VIGYAN PRASAR

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MISSIONS DEFINING INDIA'S GROWING SCIENTIFIC PROWESS

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- GERONTOLOGY: AN ESSENTIAL APPROACH TO NATION BUILDING

VIGYAN PRASAR

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NAKUL PARASHAR

Fulfilling the Scientific Social Responsibility

IT WOULDN'T be an exaggeration to say that technology has been changing at a breakneck speed. While it took long for the Industrial Revolution 3.0 to get recognised as 4.0, the demarcation between 4.0 and 5.0 hasn't been remarkably discrete. Time-wise, domain pundits claim that it was 2011 when Industry 4.0 came to the fore with enhanced automation. With much more enhancement in automation, it has been practically tough to set aside the start of the fifth industrial revolution. With the deployment of intelligent machines, duly and timely informed systems, and quality & quantity parameters in manufacturing, the services sectors have witnessed a quick ascend. Name it any industry, including advanced artificial intelligence techniques, the turnaround time efficiency is on a steep rise. Biomedical research, too, saw this. While the world combatted the deadly SARS-CoV-2, as compared to previous efforts in developing a vaccine, this time it was relatively quick and effective, and that too at a level which was too huge – a pandemic!

Yet, the moment respite from COVID-19 appears on the horizon, news of a new variant somewhere on the globe emerges. That creates another uneasiness. Scars from the previous waves of COVID are still fresh. One good thing that occurred is that the commoner on the street is fully aware of the protocols to be followed, whether endemic or pandemic. At least science & technology communication has found its importance with the scientific community and the general public.

In this connection, in the new policies, whether the science-technology-innovation one or the education one, the need to take science & technology closer to the society has been felt strongly. Analogous to corporate social responsibility (CSR), the Government of India, in May this year, brought out a similar concept called scientific social responsibility (SSR). To take complex yet socially helpful and productive scientific information to the masses is an integral part of the SSR. Like any other concept, SSR has its own set of challenges. We need scientists to be trained to create complex-understood content in a widespread manner so that a commoner can understand. Besides English, this content needs to be prepared in Indian languages so that language-related barrier is taken care of. Science & technology communication, popularisation, and its extension (SCoPE) have many more problems. To meet these challenges, we would require many more science communicators. For this, we would need to impart regular training through various media – print, electronic, social, and digital. Regular training workshops would be required, and new job opportunities in SCoPE would have to be launched. For this, every S&T institute, university, and organisation would need to have at least one SCoPE specialist. This way, new job avenues would get created in the domain.

For many years, Vigyan Prasar has been producing a 52-episode radio serial that is broadcast on All India Radio on different topics. Interestingly, a serial called Welcome Tomorrow on various aspects of Artificial Intelligence just concluded. Produced and broadcast in 19 Indian languages from over a dozen FM stations and more than 120 MW radio stations, these serials would witness a new one shortly on Aatmnirbharta (Self Reliance) through science & technology. Stay tuned!

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RAYIES ALTAF AND KIRTY SHARMA

MISSIONS DEFINING INDIA'S GROWING SCIENTIFIC PROWESS

From deep oceans to high skies India's scientific and technological missions are set to redefine the frontiers of knowledge and broaden our understanding of the natural world around us.

THE creation of new knowledge is becoming a hallmark of modern societies. This new knowledge is helping humankind to better manage the social and the natural world. Scientific and technological progress is extremely crucial to sustainably manage our natural resources. With the rational application of scientific knowledge and judicious use of technological innovations, the dream of an egalitarian world, with equal opportunities of progress and prosperity for everybody can be achieved.

Scientific knowledge and technological capabilities of any country play a significant role in enhancing its national wealth. India, being one of the fastest growing economies in the world, is also making its mark on the global scientific landscape.

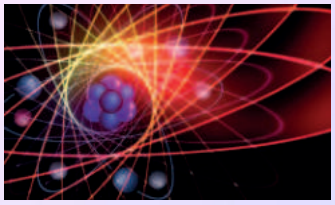
In order to achieve the goal of self-reliance and becoming a global innovation hub, India has launched nine scientific and technological missions in the recent past. These missions are overseen by the Prime-Minister's Science, Technology, Innovation, Advisory Council (PM-STIAC). The Council is an overarching body with the mandate to assess the status of specific S&T domains in India, address the challenges, formulate mid- and long-term interventions and thus present a roadmap to the leadership. The nine missions range from sustainable use of oceanic resources to usage of Quantum technology in our day-to-day life and expected to bring the much needed synergy and collaboration between various agencies and departments of the Government of India.

(Source: https://bit.ly/3zCePBi)

NATURAL LANGUAGE TRANSLATION

This aims to provide easy access to knowledge and information to all. Using a combination of technological and human translation, the mission will enable access to teaching, learning, and researching material bilingually – in English and in one's native Indian language or mother tongue. By harnessing Natural Language Processing techniques and Artificial Intelligence-based software tools it will help to overcome the language barriers and make the wealth of knowledge available across the Internet and other digital platforms in major Indian languages. This mission would be executed by the Ministry of Electronics and Information Technology, Ministry of Education, and Department of Science & Technology (DST).

QUANTUM FRONTIER



This aims to build capacities in high-end Quantum science which would help in the development of powerful quantum computers, fast and smooth quantum communications, sensitive quantum sensors, new materials with unique features, and above all help in strengthening our national security. This mission would see the partnership and collaborations of top scientific and research departments of the government such as the DST, Department of Space, Department of Atomic Energy, Defence Research and Development Organisation (DRDO), and Ministry of Electronics and Information Technology. In the Union budget for 2020-21 $1.12 bn (₹8000 crores) has been allocated to build the quantum capabilities of the country. DST has set up Quantum-Enabled Science & Technology (QuEST) – a research program to achieve the objectives of this mission.

(Source: https://bit.ly/3xs8cPi; Credit: www.iqlect.com)

ARTIFICIAL INTELLIGENCE

This aims to develop core research capabilities in the country by accelerating pan-India industry-academia collaborations and focus on areas and efforts that will see direct applications in healthcare, education, agriculture, smart cities, infrastructure, and transportation. This mission will see creation and deployment of applications for better connectivity and enhanced productivity. The lead agencies for this mission include NITI Aayog, DST, Ministry of Electronics and Information Technology, and Department of Biotechnology. NITI Aayog will establish the National Programme for AI to guide the research and development of new and emerging technologies. India's National Artificial Intelligence Portal, 'INDIAai' has also been launched in this direction as a one-stop digital platform for AI-related developments in India.

ELECTRIC VEHICLES

India is largely dependent on oil imports for its daily energy needs. Currently, India's annual oil import bill stands at around 100 billion USD (₹10000 crores). To ease this huge burden and cut our dependence on foreign oil, the National Electric

(Source: https://bit.ly/3HmMReR)

Mobility Mission Plan (NEMMP) 2020 has been conceptualised. The mission aims to cut fossil fuel consumption and mitigate the emissions. It would not only redefine India's urban and rural mobility sector through the development of electric motors, Lithium-Ion batteries, and power electronics but also help mitigate the problem of air pollution in urban areas caused by diesel and petrol-run vehicle. The lead agencies for this mission include DST, Department of Heavy Industries, Ministry of New and Renewable Energy, Ministry of Power, and NITI Aayog. An ambitious target to achieve 6-7 million sales of hybrid and electric vehicles from 2020 onwards is set under the NEMMP 2020. As part of this mission, the Government of India seeks to realize the dream of 400 million customers by the year 2030. Taking a major step towards achieving these targets, the government announced the Phase II of the Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme, with an outlay of ₹10,000 crore for a period of 3 years starting from 1 April 2019. The scheme includes giving incentives to the customers for purchasing electric vehicles and incentives to the manufacturers for research and development besides developing the charging infrastructure. In addition to the economic benefits, especially the job creation potential in the MSME sector, switching to electric vehicles will also have significant environmental benefits such as mitigating the air pollution. Vehicles eligible under the FAME II scheme can save 5.4 million tons of oil equivalent over their lifetime, worth ₹17.2 thousand crores.

DEEP OCEAN EXPLORATION

(Source: https://bit.ly/3aYPPKe)

Our oceans are full of lifeforms and resources. If used judiciously and managed sustainably, they can lessen the burden on our land resources, which are currently under huge pressure because of overexploitation, to meet the demands of industry and markets. Deep Ocean Mission which has an estimated budget of ₹4077 crore is aimed to explore deep ocean resources and to develop deep sea technologies for sustainable use of these resources. About 95 percent of the Deep Ocean remains unexplored. For India, with its three sides surrounded by the oceans and around 30 percent of the country's population living in coastal areas, the ocean is a major economic factor supporting fisheries and aquaculture, tourism, livelihoods, and blue trade. Oceans are also a storehouse of food, energy, minerals, medicines, modulator of weather and climate, and they underpin life on Earth. Deep ocean mission is expected to give a major boost to the blue economy of India and the Ministry of Earth Sciences is the nodal agency for this mission.

SIX MAJOR COMPONENTS OF DEEP OCEAN MISSION

1. Development of Manned Submersible which can carry three people to a depth of 6000 metre in the ocean and other deep-sea mining technologies;
2. Development of ocean climate change advisory services where new information and climate models would be created to understand climatic conditions in oceanic environments and to provide future projections for the same;
3. New technological innovations for exploration and conservation of deep-sea biodiversity;
4. Deep Ocean Survey and Exploration for creation of new knowledge and databases related to our oceanic resources;
5. Explore technologies and means to acquire energy and freshwater from the ocean;
6. Creation of an advanced marine station for ocean biology to provide an impetus to oceanic biology research.

The agencies which have been entrusted with implementation of this mission include Ministry of Earth Sciences, Department of Biotechnology, Department of Space, Ministry of New and Renewable Energy, Oil and Natural Gas Corporation, DRDO, Geological Survey of India, and National Biodiversity Authority.

With the launch of the Deep Ocean mission India has become part of a select group of nations which have capability of travelling and exploring deep ocean floors. The other nations with similar capabilities and technological know-how include China, France, Germany, Japan, South Korea, and Russia. In 2019, the government of India launched a ₹8,000-crore Deep Ocean to explore depths of the ocean. The mission has multiple aims including exploration of metals and minerals. India has also been allotted a site of 75,000 sq. km. in the Central Indian Ocean Basin (CIOB) by the UN International Sea-Bed Authority for the exploitation of polymetallic nodules (PMN). Just utilizing 10% of the PMN reserve available in the area, the country can meet its energy requirements for the next 100 years.

WASTE TO WEALTH

The national mission on waste to wealth which is being spearheaded by office of the Principal Scientific Adviser

(PSA), Government of India aims to identify, develop, and deploy technologies which can be used to treat waste to generate energy, identify recyclable material and create other valuable resources from it, etc. The mission is aimed to explore, identify, and support the development of such modern technologies that promise to create a clean and green environment. The mission will assist and augment the Swachh Bharat and Smart Cities projects by promoting waste management initiatives in the country. The mission also aims to create such economic models that are financially viable for waste management practices and streamline waste handling in India.

(Source: https://bit.ly/3aYPPKe)

NATIONAL BIODIVERSITY

With a human population of more than 1 billion and nearly 8% of the world's biodiversity thriving in the region, which is only 2.3% of the Earth's land mass, India is incredibly rich in lifeforms. Keeping in view this rich flora and fauna and the fact that biodiversity has an inevitable role in ecological well-being, the National Mission on Biodiversity has been launched with the aim of bringing biodiversity and conservation efforts to the forefront of policy and research and development. The mission proposes a national effort to transform biodiversity science by linking it to the peoples' economic prosperity. It comprises documenting India's biodiversity, with the aim of cataloguing and mapping all lifeforms in the country and to assess their distribution and conservation as well as their cultural and socio-economic significance.

BIOSCIENCE FOR HUMAN HEALTH

The science of our genes and genomics is becoming essential in understanding, predicting, and treating illnesses and diseases of various kinds. To strengthen the research base of genomics in the country, the government launched the National mission for Bioscience for human health. The objective of the mission is to construct reference maps of genomes of the country's population and to understand the dynamics of how exposure to different environments impacts our bodies. It would carry out genomic study of different populations of Indians and thus explore, identify, and reveal prevalence of rare and inherited diseases. As part of this mission, healthy and diseased samples would be studied to understand the impact of nature and nurture (environment and food-habits) on our health. Leading partners for this mission include Department of Biotechnology, Department of Health Research, Ministry of Health and Family Welfare, DST, and Department of Atomic Energy.

AGNIi

Mission AGNIi (Accelerated Growth of New India's Innovations) is aimed to provide the much-needed thrust to India's innovation ecosystem by promoting the idea of techno-entrepreneurship. This would be achieved by creating networks of scientists, innovators, industry, and the market. Through this mission, specific needs of the industry will be linked to our research laboratories to enable development of cost-effective marketable solutions. The mission also aims to commercialize and facilitate market access to innovations coming from government-funded research laboratories besides building capacities in areas such as technology transfer and technology licensing. This will enable the country's innovation ecosystem to grow and make its presence felt in international markets. Invest India is the lead partner in this mission.

With these missions, India is set to claim its leadership in the global knowledge economy and to tread on the path of sustainable development. These nine missions will open-up new vistas of knowledge creation and information sharing and will thus contribute to the peace and prosperity of the nation. They represent the voice of new-age India's new aspirations.

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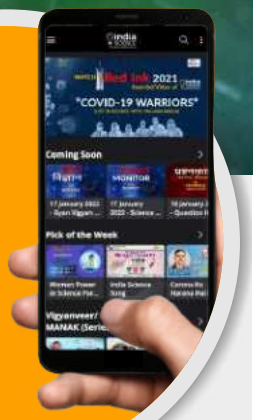

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ABHAS MUKHERJEE

GARY STARKWEATHER: Inventor of the laser printer

Unlike conventional printing where a block or plate coated with ink is used for printing, laser printing is an electrostatic digital printing process. It produces high-quality text and graphics by repeatedly passing a laser beam back and forth over a negatively charged cylinder called a "drum" to define a differentially charged image, which is then transferred to paper using a toner. The laser printer brought the power of the printing to almost anyone.

The laser printer was invented by Gary Starkweather, an American engineer and inventor. Born on 9 January 1938 and raised in Lansing, Michigan, USA, Starkweather grew up interested in model trains, radios and other electric gadgets. His house was near a junk shop, where Gary could bargain for old radios and clocks, washing machines, and car parts. He used to constantly tinker with these in the basement of their house. Neighbours sometimes called to complain that his experiments temporarily interfered with television reception at their premises. "As long as I didn't blow up the house, I was allowed to do whatever I wanted down there," he said in a 2010 interview with the Computer History Museum.

Gary's house was barely 5 kilometres from the Michigan State University (MSU). He enrolled there after high-school graduation. Although initially interested in electrical engineering, Gary opted for a bachelor's degree in physics. Actually, he was inspired by his physics teacher, T. Harvey Edwards, whose area of specialisation was optics. This created Gary's interest in optics. Explaining how his interest in optics grew, Gary said, "Dr Edwards was working on molecular spectroscopy–he was trying to determine the physical distance in molecules of certain types of chemicals. That involved the use of a spectrometer, diffraction readings, lenses, etc., and I was hired to help with data reduction. This got me very excited about optics–I was particularly fascinated with the lenses and what they did. So, after graduating from MSU, I headed to the University of Rochester, the only university in the country at the time that offered a formal degree in optics."

Dover was one of the early laser printers Starkweather developed at PARC in the 1970s. (Source: Xerox)

Gary received his bachelor of Science (B.S.) in physics from the Michigan State University in 1960. In 1961 he moved to Rochester, New York. In 1962, he joined Bausch & Lamb, Inc., which at the time used to make lenses for eyeglasses, cameras, microscopes, and other equipment. In 1964, he joined Xerox Corporation, intrigued by the imaging technology the company was developing. He was appointed a senior research fellow at Xerox. In 1966, Starkweather received his Master of Science (M.S.) in optics from the University of Rochester.

One of his initial projects at Xerox was the high-speed facsimile machine. Faced with the challenge of getting enough light on the paper and creating an image by the output device, Starkweather suggested using lasers, a new technology then. One day in 1967, he was sitting in his lab looking at these mainframe facsimile machines when he started thinking, "What if, instead of copying someone else's original, which is what a facsimile does, we used a computer to generate the original?" And so, the idea of the laser printer was born.

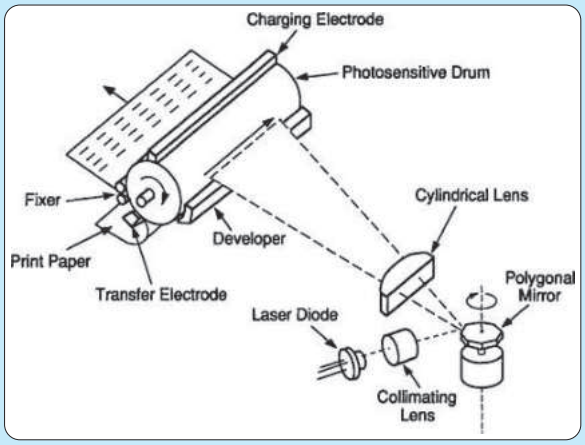
Laser printing was a revolutionary change from the computer printers that were in vogue in the 1960s, which were noisy contraptions resembling automated typewriters. They rattled out simple lines of text, with little variation of font or spacing. Sophisticated graphics were out of the question then.

The technology at the time used a photographic lens to copy an image from one sheet of paper to another. Starkweather wondered whether it might be possible to skip a step in the process-namely, the use of physical document-and send an electronic signal directly from a computer terminal to a printer. While officially working on a fax machine at Xerox Corporation, Starkweather began to experiment in his spare

time with copy machines and digital technology, in effect trying to merge the two. He wondered whether he could use lasers (about which he studied in his graduate courses in holography) in printing. Starkweather's supervisor at Xerox discouraged his experiments, calling them laser "toys". He was, therefore, forced to conduct his work in secret in a hidden corner of a laboratory.

Gradually, after experimenting with lasers and optical lenses, he began to get results. Even then, it required some persuasion before the corporate executives of Xerox gave the green signal to the laser printer developed by Starkweather, which finally hit the market in 1977. Dubbed as Xerox 9700, the laser printer became one of the most successful printers in the company's history, making it possible to print directly from computers and leading to a revolution in printing technology.

The first laser printer, Xerox 9700 (Source: Xerox)



Schematic diagram of a laser printer (Source: ScienceDirect)

In 1970, Xerox announced its plans to build the Palo Alto Research Centre (PARC) in California. On contacting PARC, Starkweather received a positive response for his project. In 1971 he moved from Rochester to California. At Palo Alto, Starkweather used a laser beam to draw an image onto the copier drum. His next step was to create SLOT, an acronym for Scanned Laser Output Terminal, for which he used a Xerox 7000 copier. In 1972, in cooperation with Butler Lampson and Ronald Ride, he added a control system and character generator. A laser beam carried digital information, and the copier then developed the imaged digital information to make a print. The combined efforts of the trio resulted in a printer named EARS (Ethernet, Alto, Research character generator, Scanned laser output terminal). The EARS subsequently came to be known as Xerox 9700 laser printer, which was launched in 1977. It became one of Xerox's best-selling products. In fact, Xerox 9700 laser printer made billions of dollars for Xerox, the most commercially profitable product to come out of the PARC facility. The first laser printer designed for use in an office setting–the Xerox Star 8010–was subsequently released in 1981. The first mass market laser printer–the Hewlett Packard Laser Jet 8ppm–was released in 1984.

After about 24 years of distinguished service, Starkweather left Xerox in March 1988. From March of 1988 until May of 1997, he was employed by Apple Computer as an Apple Fellow. Here he was involved in publishing and colour imaging products and research. His time at Apple resulted in the invention of a colour management technology as well as the development of Coloursync 1.0. In May 1997, he joined Microsoft Corporation in Redmond and became an Architect in Microsoft Research, working on novel information hardware, such as large-and high-resolution displays. While at Microsoft, he authored several papers on displays and Micro Electromechanical Systems or MEMS technology. He also worked on optical security technology with other technology groups at Microsoft. Starkweather worked for eight years with Microsoft Corporation from where he retired in 2005. After retirement, he moved with his wife to DeBay, Florida.

Achievements and awards

Starkweather published many papers and wrote a book chapter entitled *High Speed Laser Printer* for Academic Press. He served on several technical committees involved in display and colour-related imaging issues and lectured at both Stanford University and University of California, Los Angeles (UCLA). He was a fellow of the Information Services and Technology (IS&T) as well an Honorary Member and was also a fellow of the Society for Information Display.

He spent more than 43 years in the imaging sciences and held more than 44 patents in the fields of imaging colour and hard-copy devices. In 1977, Xerox presented him with the Xerox President's Achievement Award. In 1987 he received the Johann Gutenberg Prize from the Society for Information Display, and in 1991 he received the David Richardson Medal from the Optical Society of America. In 1992, he received the Engineering Excellence Award, also from the Optical Society of America. In March 1994, he received a Technical Academy Award for his consulting work with Lucasfilin and Pixar on colour film scanning. In November 2002, he was inducted into the Technology Hall of Fame at Computer Dealer Expo (COMDEX). In 2004, he was elected to the United States National Academy of Engineering, and in 2012 he was added to the National Inventors Hall of Fame.

Starkweather was peacefully living his retired life with his wife at Florida, pursuing his hobbies like astronomy, music, and model railroading till his death at the age of 81, on 28 December 2019.

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SAGARIKA CHAUDHURI

Egyptian cobra

Rattlesnake from South America

Krait from Thailand

SNAKEBITE ENVENOMING:

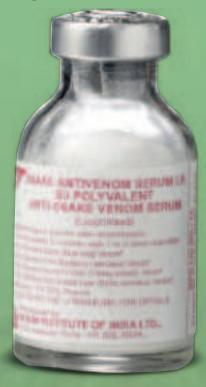
A Saga of Suffering and the Quest

As per available data it is heartening to know that even in this 21st century, about 5 million snakebites occur each year globally with about 2.7 million envenomings. In 2019, about 81,000 to 138,000 deaths were reported from venomous snakebites with several cases remaining unreported. Lots of amputations and permanent disabilities are a common occurrence in many parts of the world. In India, about 2.8 million people are bitten by snakes, and each year about 58,000 snakebite deaths occur. Eventually, Snakebite Envenoming (SBE) was affixed by the World Health Organization (WHO) in June 2017 to its priority list of Neglected Tropical Disease (NTDs) Category A. It has been found that cases are highest in Sub-Saharan Africa, South Asia, and South-East Asia, the world's most populated regions. According to WHO, SBE is a disease in urgent need of attention to reduce the medical and societal burden.

The Disease

A mixture of different toxins or venom injected through the biting of venomous snakes is referred to as snakebite envenoming. Envenoming though sometimes occurs not by biting or injecting but through spraying of the venom by certain species of venomous snakes.

Human-Snake conflict may eventuate in snakebite envenoming and mortality. The afflicted ones are mostly agricultural workers, poor rural dwellers, fishermen, working women and children, people living in poorly constructed houses (often thatched huts), and people with limited access to healthcare. According to some, people with much less or no so-called political, social, and intellectual voices can be added to this list of distressed people.



SII Polyvalent anti-snake venom serum

Executors

More than 3000 living species of snakes are present in the world, and about 250 species are tagged as medically important by WHO, because of the harmful effects of their venoms. Venomous snakes are categorized under Suborder Ophidia (Serpentes), Clade Caenophidia (advanced snakes), and four of the families Atractaspididae, Colubridae, Elapidae, and Viperidae.

Snakes responsible for a majority of snakebites around the world are saw-scaled viper, Egyptian cobra, monocellate cobra, puff adder, black mamba, Russell's viper, krait, Malayan pit viper, Papuan taipan, brown snakes, lancehead viper, and rattlesnake.

Over 50 snake species out of 285 known species of snakes in India are capable of delivering a harmful or fatal bite. Russell' viper, spectacled cobra, monocellate cobra, king cobra, common krait, banded krait, wall's krait, Sind krait, black krait, lesser black krait, saw-scaled viper, Sochurek's saw-scaled viper, hump-nosed pit viper, Cantor's pit viper, and the hook-nosed sea snake are highly venomous Indian snakes. The spectacled cobra, Russell's viper, common krait, and saw-scaled viper are the so-called "Big Four", which are responsible for the majority of life-threatening envenomation.

Snake Venom

In snake venom, there is a diverse collection of larger proteins and peptides which results in a great variety of pharmacological and toxicological effects. These venoms comprise 50-200 components distributed in dominant and secondary families.

There are mainly two components in snake venom. These are Proteins and peptides components having both enzymatic properties and non-enzymatic properties and Non-proteins and peptides components including Metal ions, carbohydrates, nucleosides, free amino acids, and lipids.

Effects of Snakebite Envenoming

Three main types of pharmacological effects of snake venoms are hemotoxic, neurotoxic, and cytotoxic. PLA2s, SVMPs, SVSPs, and 3FTXs are the major toxins


Russell's viper and Spectacled cobra-India

that are either alone or in combination and are responsible for the multiple pharmacological effects occurring in snakebite envenoming. The local effects appearing through the bite from a snake range from local pain and swelling to tissue necrosis.

Snake Antivenom: The bliss

High-quality and appropriate snake antivenoms are still the only and most effective treatment for snakebite envenomings. They are on the WHO List of essential medicines. Moreover, strategies adopted by WHO target a 50% reduction in disability and mortality caused by venomous snakebites by 2030.

Use of animals for the production of antivenom

Animals are used for the production of life-saving antivenom. Venomous snakes are maintained in serpentaria for use in venom production and are maintained according to nationally- and internationally-accepted standards. Horses, ponies, mules, and sheep are used for the production of hyperimmune plasma in antivenom production. Relevant guidelines and regulations established by competent authorities are implemented to ensure the social, physical, and environmental needs of these animals.

BE Polyvalent anti-snake venom serum

VINS Polyvalent anti-snake venom serum

Procurement of snake venom in India

Mr. Romulus Whitaker and Smt. Revathi Mukharji once decided to use the traditional skills of Irulas for the production of snake venom. As a result of their efforts Irula Snake-Catcher's Industrial Cooperative Society (ISCICS) was established in 1978 with 25 members. Now it operates in two districts of Tamil Nadu and is the largest producer of venoms in India. The Irulas bring freshly caught venomous snakes to the centre for venom extraction.

Production of Antivenom

Polyvalent anti-snake venom serums are produced by some institutes in India (see box) and are distributed all over India. Available commercial antivenoms are now produced based on the original principle of producing hyperimmune serum from animals by gradually exposing them to sublethal doses of targeted venom with an adjuvant. The purification procedure of hyperimmune serum takes place to produce whole immunoglobulin G (IgG) antivenoms and the fractionation of IgG to produce F(ab) and F(ab')2 antivenoms.

Poor effectiveness against venom-induced local effects containing a large proportion of clinically irrelevant antibodies, frequent allergic reactions, complex manufacturing process, and high batch-to-batch variation are the major drawbacks of the current antivenoms. Camelid IgG and non-IgG components are tried as they are found to be less reactogenic and more thermostable. Some promising developments are going on with humanized and human monoclonal antibodies and their fractions against snake toxins. Oligoclonal antivenoms containing selected monoclonal antibodies and fragments with specific venom inhibitors may be a potential way forward in future antivenom therapy. With the gradual reduction in costs of such technologies, affordability of future improved antivenoms may be ensured.

INDIAN INSTITUTES PRODUCING POLYVALENT ANTI-SNAKE VENOM SERUM:

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7. Bharat Serums and Vaccines Limited, Mumbai
8. Mediclone Biotech (Chennai) Private Limited, Chennai

Prevention is the mother of cure

To avoid bites and envenomation following preventive measures and guidelines are recommended by WHO:

- Times of day, seasons of activity, and favourite habitats of local snakes are to be known.
- Snakes should not be handled, threatened, or attacked.
- A well-tucked mosquito net on a raised bed to be used for sleeping.
- Solid shoes or boots, long trousers are recommended.
- Fishermen should not touch sea snakes caught in their nets.
- Light and prod with a stick should always be used while walking outside at night.
- Snake antivenom should be a part of any primary healthcare package where venomous snakes occur.
- For general public awareness, community education may be accomplished through lectures, video shows, leaflets, banners, and posters.
- If bitten, the snake is to be identified first (as far as possible) and the patient should be hospitalized immediately with no trial of traditional cure.

Live and let live

Snakes may cause suffering to humans, but they are also the primary source of antivenom. Estimating their role on the planet, these creatures should be protected and let live.

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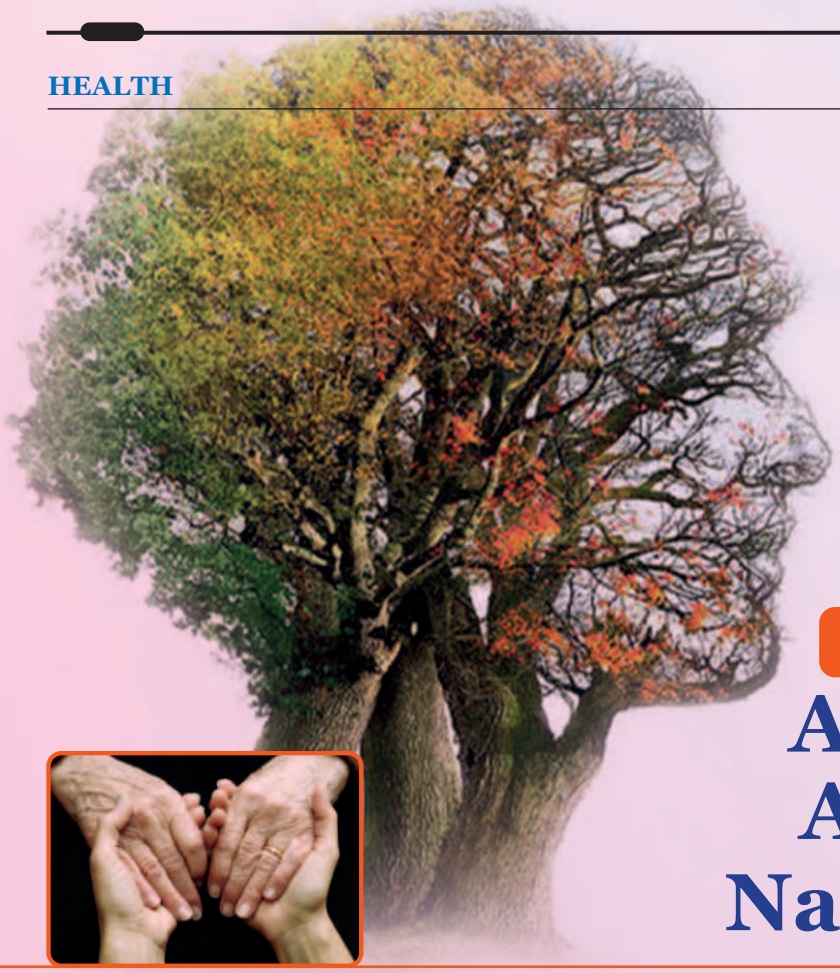
KANTI BHOOSHAN PANDEY



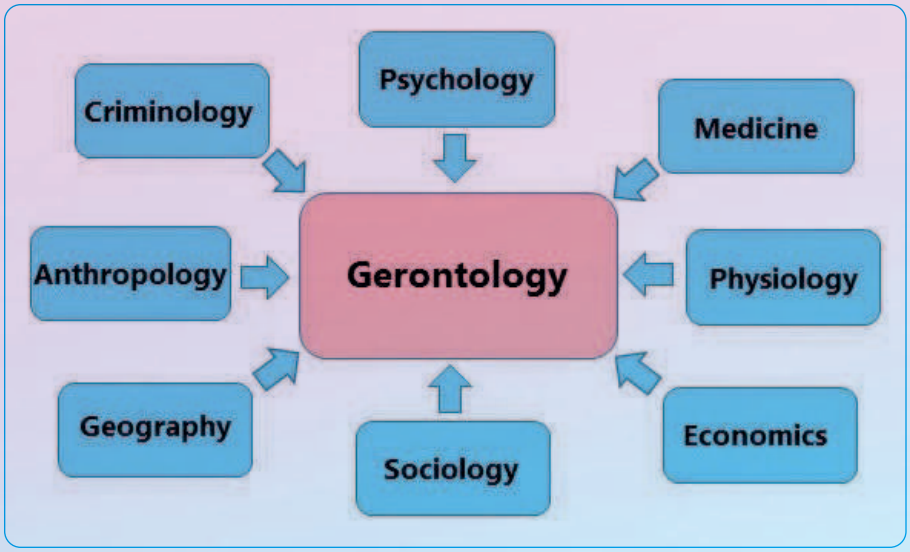
GERONTOLOGY: An Essential Approach to Nation Building

It is said that curiosity is mother of invention. It is also what keeps science alive and progressive. Understanding the process of aging and its prevention is probably one of the most ancient living desires of humans since evolution. Science has also evolved and promoted itself on the basis of constantly changing ethos of nature and 'Gerontology' is one of them. Gerontology can be defined as the study of the aging process and about older adults. Advances in medical care, increased health awareness, and better economic conditions have led to increased life expectancy across the globe which is a major factor in the development of gerontology. As we celebrate 11 July as the World Population Day this multidisciplinary branch of science which includes applied disciplines such as psychology, social science, health, physiology, medicine, and policy making becomes more significant.

Although 'gerontology' has been in discussion for about a hundred years, yet most of us are still unaware of it. The word 'gerontology' was first coined by a Russian scientist Ilya Ilyich Mechnikov in 1903, which is derived from the Greek word 'geron' which means 'old person'. However, at that time gerontology did not exist as a separate branch of science and researchers working in this field were known only as scientists of physiology or medicine. Later, it expanded to other areas of science like sociology, geography, and economics. Systematically, 'gerontology' is defined as the study of the processes of aging and the life span of individuals which include the study of physiological, physical, mental and social changes in the elderly, and changes in society due to their growing population. It is extremely useful in knowledge-portfolio creation and management of the elderly population.

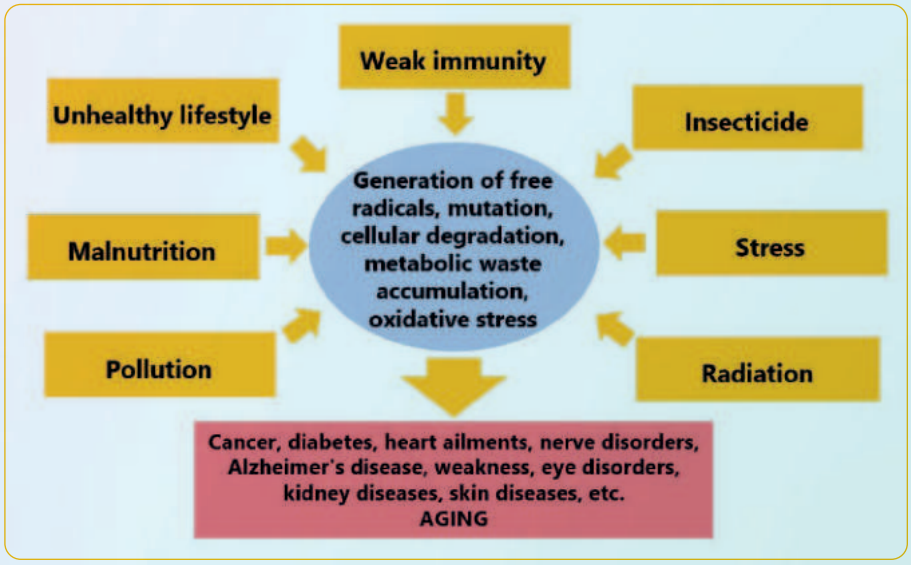
Why is gerontology important?

Aging is a universal and unavoidable truth, but from a scientific point of view, it is a disease and is defined as a progressive functional disability that over time weakens a person and ultimately leads to death. Increasing age invites many complications which include diabetes, vision disorders, decline in memory capacity, dementia and Alzheimer's disease, etc. According to Darwinism, the purpose of life is to multiply by reproduction. Until



Gerontology and related field of study

the person attains the reproductive stage, nature protects him/her in every possible way and keeps them alive. At the end of the reproductive phase, the role of nature in the life of the person ceases and the person completes the rest of the life under its own care. Therefore, aging is a continuous and naturally irreversible decline in the efficiency of various physiological processes after the natural reproductive phase is over. It is estimated that by 2050, more than 50% of the world's population will be above the age of 60. The elderly population compromises quality of life in a number of ways, including restricted mobility, dependence on others, and burden to the economy as well. In such a situation the role of gerontology and gerontologists becomes very important.



Biology of aging as per Free Radical theory

Scientific theories of aging process

More than 300 theories have been proposed to define the biological process of aging, although none of them has qualified as the final and precise theory of the aging process. Some important theories to define the aging process are Wear and Tear Theory which advocates that cells are exposed to a number of internal factors such as temperature, accumulation of metabolic wastes, etc. and external factors such as pollution, malnutrition, harmful chemicals and microorganisms during prolonged function and as a result of which become weak and inactive. This, in turn, reduces the efficiency of the body causing aging. Cross-Link Theory proposes that the end product of glycosylation, the binding of simple sugars to proteins and cross-binding with other biological molecules compromise their structure and make them malfunction. Crosslinking of DNA induces replication errors, and this causes cells to deform, increasing the risk of life-threatening diseases such as cancer, heart ailments, and kidney and nerve diseases, which promote aging; According to the Mutation theory, over the time, harmful mutations occur in the genetic material that deform the cells and adversely affect normal biological functions and the person progresses to aging. Telomerase Theory says that the sequences of nucleic acids at the ends of chromosomes that function to maintain the integrity of chromosomes, known as telomeres. Telomeres shorten at every cell division, affecting the integrity of chromosomes, leading to increased cellular decay and the onset of aging.

The most accepted theory of aging is Free-radical theory, proposed by scientist Denham Hermann in the 1950s. This theory provides the best mechanistic description of the aging process and related events. According to this theory, highly reactive free radicals are produced naturally within the body during normal metabolic processes and are balanced with the body's inherent antioxidant system. However, a weak immune system, exposure to ultraviolet rays, pesticides, pollutants and malnutrition, increase production of these free radicals and it is beyond the control of the body's defence mechanism and a condition prevails known as oxidative stress. Oxidative stress damages cellular machinery, creating metabolic waste products. These waste materials interfere with the synthesis of proteins, prevent rejuvenation, and denature cellular enzymes and overall condition leads to aging.

Opportunities in gerontology

Gerontology studies the physical and mental challenges of aging individuals, on the basis of which government programmes and policies are designed. Gerontologists help in reducing the dependence of elderly people on others thus protecting the manpower of the country. It is estimated that the elderly population will overtake the younger population in the coming 50 years. This large group of elderly people will result in a growing demand for health and social services and gerontology professionals. The field of gerontologists is vast, requiring researchers, educators, policy makers, and subject-specific practitioners to understand health, allied health and old-age care, as well as human resources who understand the bioprocess of aging. Degree, diploma, and certificate-level courses in gerontology are available in universities of many countries of the world. Possible careers in gerontology include social work, research, occupational therapy, education, healthcare and management, nursing, and administration. It is anticipated that soon gerontology will also become an important subject in the universities as a 'look ahead of time' approach is essential for scientific research and nation building.

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SUMAN BAJPAI

Indigenous Rice varieties and its conservation

Rice is a staple food in most of the Indian households, especially in south, and north and eastern states. As it is easy to cook and digest, people of every age group enjoy it. India is the second largest rice-growing country worldwide. Ninety per cent of it is consumed by Indians only. Other than long grain basmati, there are hundreds of indigenous varieties found in our country. A study reveals that India had nearly 1,10,000 varieties of rice till 1970 and this diversity has been effected because of the green revolution. As green revolution emphasises on hybrid crops, now we have only 6,000 species or varieties of rice available with us.

Sufficient monsoon rains results in increased yields in rice production. However, sustainability of rice production in several states is a great concern. Through irrigation, rice is also grown in areas that receive comparatively less rainfall.

Black rice of the Northeast

The quality of the rice is decided according the size of the grain-long, medium, or short. Longer cylindrical ones are characterized as long rice and short and wider ones are known as the short grain varieties. Assam is a major rice-growing area. Due to its variation in micro-climate, a large number of indigenous rice varieties can be found here. Interestingly in some places like Manipur, black rice is eaten for its medicinal value and anti-carcinogenic properties. Black rice has a unique fragrance. It is a sticky variety that is grown through paddy field farming. Locally it is known as Jaha rice.

Chokuwa

'Chokuwa' is one of the rice varieties which has been listed under the coveted 124th Geographical Indications (GI) Registry Journal. Bora Saul is one of the varieties found in Assam, and during festivals like Bihu, it is served with Doi (curd), Gur (Jaggery) and Cream.

Rice varieties from Southern India

In Kerala, parboiled red rice is preferred with varieties ranging from Thondi and Paal Thondi from Wayanad, to Kuruva, Chitteni, and Chettadi from Thrissur and Palakkad. Another red rice, Poongar, grown in Tamil Nadu is called the women's rice, which has properties that help women overcome many a health problem. Many indigenous rice varieties are now conserved by the farmers. These are gaining popularity and farmers are getting high prices for their produce. Preferred by the Wodeyar

Manipur Black Rice

Poongar

kings of Karanataka, Rajamudi rice is being revived by farmers. A mix of red and white grain is used in South Indian households.

Andhra Pradesh ranks third in rice production in India, with about 128.95 lakh tons of produce. Rice is grown throughout the state, providing food

Chitti Mutyalu

for its growing population, fodder for the cattle, and employment for the rural masses. Some of the varieties cultivated in Andhra Pradesh and Telangana are Chitti Mutyalu, Kurnool Sona or Sona masoori, Bangaru Theegalu, etc.

Part of life

In West Bengal, rice is an integral part of their life, starting with mukhe bhat (introduction of rice to the infant) and ending with an offering made to the departed souls. As a staple diet, it allows them to prepare different food items like piteh (rice cake), chire (flat rice), khoi (puffed rice), chaler payesh or kheer (sweetened rice) and muri (rice bubbles).

Known as the rice bowl of India, Chhattisgarh is home to over 20,000 varieties of indigenous rice. The varieties include non-aromatic, aromatic, wild, cultivated, and more. Each district in Chhattisgarh has a unique aromatic rice variety that has been in existence for hundreds of years. The traditional practices followed by the farmers of that region have given a distinctive identity to a variety of rice like Vishnu Bhog in Pendra, Jeeraphool of Ambikapur, Shyamjeera of Surajpur, Bisni of Bagicha, Badshah Bhog of Jagdalpur, etc.

Conserving rice varieties

There are several institutional and governmental initiatives that are working towards conservation of indigenous rice varieties. These include the State Seed Testing Laboratory (SSTL) in Bhubaneshwar and Central Rice Research Institute (CRRI) in Cuttack, Odisha and Indian Council for Agricultural Research (ICAR), New Delhi. Their objective is to culture them, preserve them, and come out with high-yielding varieties. CRRI has gathered nearly 30,000 indigenous varieties, including 5,000 from Odisha itself. They are being preserved by keeping them at low temperatures of 4°C and a relative humidity of 30 per cent. Scientists genetically cleanse indigenous varieties of their weak and vulnerable characteristics to boost their protective potential and resistance capacity.

Revival of many traditional rice varieties that are resistant to pests and disease, capable of dealing with floods and drought, and that have valuable medicinal properties, has been done by the Centre for Indian Knowledge Systems (CIKS). The old-style bamboo storage structures and earthen pots are also used to store paddy grains. This system prevents the grain from getting wet after drying and protects it from insects, rodents, and birds.

Many NGOs are now engaged in paddy conversation and its cultivation. Many farmers are not aware if their varieties are genetically pure or not. These NGOs guide them in such works.

Ghani Khan, a farmer from Kirugavalu, a village in Mandya district, Karnataka is passionate about preserving the varieties of rice. He has conserved over 700 varieties. These crops are harvested carefully, and the panicles laden with grain are bunched, marked with names and numbers, and arranged systematically on the walls of the two-room museum he has built for this purpose. He also stores them in bottles to be given away to farmers. He wants the farmers to experiment with the heritage crops they lost in the race to boost harvest with new varieties.

Red Rice is a special variety of rice that gets its colour from its anthocyanins content. With red husk and partially hulled, this rice has high nutritional values and a nutty flavour. As the fat content is zero, it is considered to be good for weight loss. Loaded with both soluble and insoluble fiber, it is in great demand these days.

Brown rice, considered as a whole grain, is also very popular because it contains all parts of the grain: bran (full of fiber), germ, and endosperm. It is recommended by the doctors as whole grain foods can reduce cholesterol and lower the risk of stroke, heart disease, and type-2 diabetes.

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M. A. HAQUE

TIGERS: Myths and Facts

Most people are frightened of tigers. In literature too tigers are depicted as a powerful and dreadful beast. Common misconception is that it is very dangerous and it attacks humans. Misinformation and lack of knowledge about tigers is common resulting in this fright.

Certain features of the tiger are helpful in hunting. Their claws remain embedded in the paw while walking. That helps in their smooth movement and the claws are not injured. While attacking, the claws project out like strong hooks and injure the prey and hold it firmly. Simultaneously, the tiger uses its jaw to hold the prey using long and pointed canines. This renders the prey immobile and helpless.

Tigers can see easily during the night. Their retina reflects the light inside facilitating to see better. Their night vision is six times better than human. Tiger's pupils are round and the iris is yellow in colour. Only in white tiger it is blue. Tigers' body hairs are sensitive, helping to feel the surrounding even while moving. The two legs of each side move almost together resulting in gliding movement. Hence, the surrounding is not disturbed and almost no sound is produced. The prey is unable to detect the presence of the tiger in its vicinity and gets caught. Another feature of the tiger is that it can balance its body well while running at full speed. Its tail is moved to balance the body weight like the rope walkers carrying a rod in their hand. Also, the tail is used to transmit signals among each other.

Tiger is large and it needs about 15 to 18 kg of meat/day. Important fact is that chances of the tiger being successful is only 5 to 10%; i.e., in 10 to 20 attempts, the tiger succeeds only once. Obviously, the tiger cannot afford to allow the prey to run away once it is able to catch. It uses all possible means to immobilize the prey. Life is more difficult for a female tigress, if it has cubs. It has to find food for herself and the cubs. Also, it cannot move freely. Cubs are small (less than 800g to little more than 1600g) and blind at birth. They are totally dependent on the mother. So, the mother's movements are restricted. Obviously it becomes more ferocious when it finds a prey.

Tigers commonly prey upon different types of deer and wild boar. They kill young elephant or young rhino as well. Bisons and wild buffaloes are quite big and not easy to attack and immobilize. Occasionally, under compulsion, tigers prey upon monkeys, reptiles, birds and fishes. Tigers and tigresses hunt alone. But tigresses with cubs hunt in groups, which makes their task easy and the cubs get better protection. A tiger/tigress survives well if it kills a large animal in eight to ten days. But a tigress with two dependent cubs has to kill large animals every five to six days.

Generally, tigers search for prey before the sunset. Often it keeps roaming the entire night and walk up to 25km in search of prey. In dense forests the days are cool. Tigers hunt even during the daytime. During the hot days they take rest in the shade of trees or in some secluded area. They may enter water bodies and remain there till the temperature comes down.

The Global Tiger Day is celebrated on July 29th every year to raise awareness about this endangered magnificent animal. It was initiated in November 2010 when world leaders from thirteen tiger range countries (Bhutan, Nepal, Vietnam, Myanmar, Malaysia, Indonesia, China, Russia, Bangladesh, India, Thailand, and Laos) met in St Petersburg, Russia for an International Tiger Conservation Forum. The aim was to increase the population of wild tigers by 100% by the year 2022 (Tx2).

Dwindling Numbers

Tigers are the largest animal in the Cat family, weighing up to 300kg. But all varieties are not that big. Siberian tigers are the largest. Earlier, there were eight subspecies of tiger. Now five survive; three-Bali tiger, Javan tiger, and Caspian tiger-are extinct. The South China tiger is critically endangered since 1996 and possibly extinct in the wild. Last confirmed sighting was in the 1990s.

Till about 1900 and 1920 there were about 100,000 tigers in the world. By 1970 only about 5000 tigers were left. By 1986, it slightly improved to about 7700 to 7800. But again the number declined. By the end of 20th century, only 5000 to 7500 tigers could be estimated. Hence, tiger is in the Endangered category of IUCN (International Union for Conservation of Nature and Natural Resources). According to WWF (World Wide Fund for Nature), by January, 2021 there were only 3890 tigers in the wild.

Historically, tigers were present from Turkey to the eastern boundary of the erstwhile Soviet Union. In South East Asia it was present in Malaysia, Singapore, Sumatra, Java, and Bali. Now it is present only from India to Vietnam and in Sumatran region of Indonesia and the eastern boundary of Russia. There are some evidences that tigers are present in North Korea and in China. However, IUCN has confirmed its presence in Bangladesh, Bhutan, Cambodia, China, India, Sumatra, Laos, Malaysia, Myanmar, Nepal, North Korea, Russia, Thailand, and Vietnam. India has the largest population. According to the latest estimate (census of 2018-19), population of tigers in India is 2967, i.e., more than 76% of the world population.

During the last century, tiger population reduced drastically. Reasons are obvious. Till recently tigers were hunted freely. Another reason is that forests have been destroyed/degraded. In 1900 globally, the forest cover was around 4,128 to 5,500 million ha. By 2021 it came down to about 4000 million ha. Shrinking forests denied suitable habitats for the tigers and also deprived them of their prey. Also, water should be available round the year. Hunting area of a tiger may extend to about 700 km2. If the tiger gets its prey easily, the hunting area may restrict to about 150 km2. When the tigers become weak or they stray outside the forests towards human habitations, they try to prey upon domestic animals and cattle. If they encounter humans, they may attack, but only under compulsion. Otherwise, tigers are shy animals and they avoid approaching humans.

Poaching, i.e., illegal hunting is another factor in reducing tiger populations. People hunted tigers, cheetahs, leopards etc. for their skin, and the head were kept as trophies.

Misconception

If the tiger is not hungry, it does not bother at all about humans. There have been instances of tigers entering homes during night and sleeping close to the humans. Only when the tigers are deprived of their abode and prey, they come out of the forest and approach human habitations. That leads to human-tiger conflicts and people consider them as enemy. At times tigers turn man-eaters. Then it becomes essential to capture those tigers and keep them in captivity or to kill them. Most of the researchers say that the tigers turn man-eaters as sufficient numbers of prey are not available. Also, villagers enter the forest area frequently to collect timber, fuel-wood and honey etc. In the process the tigers become accustomed to human presence and they become bold.

Conservation and Protection

Tiger is a protected species wherever present. It was expected that tigers would survive with these measures. But illegal trade of skin and body parts of tigers, leopards, cheetahs, etc. has made them vulnerable. People also consume tiger meat for strength and in the belief that it has aphrodisiac properties. But it is essential to protect these beautiful animals as they are the balancing forces in the forest ecosystem.

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Biotechnology Start-up Expo showcased India's S&T Expertise

A two-day expo (9-10 June 2022) at Pragati Maidan, New Delhi saw participation of over 700 start-ups working in the field of biotechnology. The expo, organised by Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology, was inaugurated by the Hon'ble Prime Minister Shri Narendra Modi.Also present for the inauguration were Shri Piyush Goel, Minister of Commerce & Industry, Consumer Affairs & Food & Public Distribution and Textiles; Dr Jitendra Singh, Union Minister of State (I/C) Science & Tech (I/C) Earth Sciences, PMO, PP/DoPT, Atomic Energy, Space; Shri Dharmendra Pradhan, Minister of Education and Minister of Skill Development & Entrepreneurship, and other dignitaries. Hon'ble Prime Minister expressed confidence that India is on the verge of becoming a part of the top 10 countries in biotechnology. "India's bio-economy has grown eight times in the last eight years. We have grown from $10 billion to $80 billion. India is not too far off from reaching the league of top-10 countries in Biotech's global ecosystem", he said. He also said that today as we pledge for the development of the country during the coming 25 years of 'Amrit Kaal', the role of the biotech industry is very significant.

He noted that there were five big reasons why India is being considered a land of opportunities in the field of biotech: diverse population and diverse climatic zones; India's talented human capital pool; increasing efforts for improving the ease of doing business in India; the steady increase in the demand for biotech products; and the successful track record of India's biotech sector. Dr Jitendra Singh spoke about the achievements of the biotech sector in the country.

Several biotechnology start-ups from agriculture, Healthcare, development of diagnostic tools, robotics, genomic study, IT-enabled services, Biotech software development, waste management, etc. participated in the expo. Industry leaders, stakeholders, students, and common people visited the stalls to know about the latest developments in biotechnology that can dramatically change their lives. For example, one start-up has come up with an indigenous machine for dialysis that will bring down the cost of the process drastically, benefitting hundreds of patients.

Some start-ups are working on developing molecules that will help in converting waste to biodegradable sludge. Portable IoT-enabled sensors have been developed that can measure moisture, temperature, electrical conductivity, etc. of the soil and a map can be generated. Based on the map the farmers can be advised to sow the crop. Cordyceps have been developed by a start-up that have huge health benefits. Agri-biologicals have been developed that will make crops climate resistant, protecting yields and crops from fluctuations, weather, untimely rains, temperature and water stress, etc.

ISW Team