The city of Tirupati known for the famous Venkateshwara temple turned into a science city in the first week of January this year. The annual event of the Indian Science Congress attracted scientists and researchers from all over the country. In addition, as many as six Nobel laureates participated in the week-long 104th session of the Indian Science Congress at Sri Venkateshwara University in Tirupati.

New scientific discoveries, latest developments from Indian research institutes and universities, science and technology policy issues were all discussed during the Congress. Besides, the Pride of India Expo organised at the Congress venue attracted thousands of school and college students from Tirupati and several other towns and cities in Andhra Pradesh.

The theme of the Congress this year was ‘Science and Technology for National Development’. Prime Minister Shri Narendra Modi set the tone for the proceedings in his inaugural address talking of challenges before science and technology in the country and how science could contribute to national development. Referring to the Technology Vision 2035 document released during last year’s Science Congress, he announced that a detailed roadmap for twelve key technology sectors will be developed to evolve a holistic science and technology vision for the country.

**Stress on Cyber-Physical Systems**

The Prime Minister highlighted the need to establish cyber-physical systems that could transform several sectors, particularly manufacturing and communication related activities. Cyber-physical systems will use computer algorithms to control physical processes. By using devices such as robots, autopilots, autonomous automobile systems, smart grids, and medical monitoring machines, cyber-physical systems will secure our future by creating skilled manpower and more opportunities for R&D. “We need to develop an inter-ministerial national mission on cyber-physical systems,” the Prime Minister said.

Referring to India’s performance in scientific research, Shri Modi mentioned that India ranked sixth in the world with respect to scientific publications, registering a growth of about fourteen percent as against the world average growth rate of about four percent as per data from SCOPUS. He said that there is a need to improve the quality of basic research, its translation to technology, and its application to meet wider societal needs. He envisaged that India will be among the top three countries in science and technology by 2030, and will be among the most
attractive destinations for the best talent in the world.

The Prime Minister also emphasised the need to empower women and train them in the fields of science and engineering. He envisaged that engaging women scientists would aid nation building. He also talked about a new concept of Social Responsibility (CSR) - on the lines of Corporate Social Responsibility (CSR) - within academia, research institutes and other stakeholders to ensure wider application of science and technology for the society and common man.

He also mentioned that India is partnering with international laboratories to establish state-of-the-art facilities like the 3.6 meter optical telescope in Devasthal in Uttarakhand set up in collaboration with Belgium, and the LIGO project with the USA, to explore outer space.

New Advances in Space Technology

The plenary sessions which followed the opening ceremony focused on developments in specific sectors such as space, renewable energy, nanotechnology and medicine.

The session on space technology attracted a huge number of participants. Speakers from different centres of the Indian Space Research Organisation (ISRO) gave an overview of the space programme in India which began in the 1960s with the establishment of Vikram Sarabhai Space Centre (VSSC) in Thiruvananthapuram. Dr K. Sivan, director of VSSC, told young members of the audience how space technology encompasses more than just traveling to the Moon and Mars as popularly believed. This technology is now touching the lives of common people all over and benefiting them in various ways – mobile communication, television broadcasting, tsunami or cyclone warning, weather forecasting and many such applications.

“By 2018, we will have the capacity to launch 8 PSLVs every year, and we may also achieve human spaceflight by 2024”, said Dr. S. Somanath, Director, Liquid Propulsion System Centre of ISRO. Chandrayaan-II is also getting ready for a launch in 2018. The moon mission will include a rover that will land on the lunar surface and study the composition of moon’s surface. Aditya-L5 mission is set to take us even closer to the Sun at L5 or Lagrangian5 point, about 1.3 million km away from the Earth towards the Sun.

Another scientific mission on the anvil is a small satellite called X-Ray Polarimeter Experiment or XpoSat, which will measure the degree and direction of the X-ray polarization of a few bright cosmic X-ray sources and help in deep space exploration studies. AstroStat, a satellite that observes galactic objects, helps us get clear and better images of our solar system than Galex, its counterpart from the US. “Our venture into deep space exploration led the discovery of an exoplanet outside our solar system, of the mass of 110 times of Jupiter. This work was made possible by PARAS (PRL Advanced Radial-velocity All-sky Search), located at the Physical Research Laboratory observatory in Mt. Abu that searches habitable planets near specific stars”, scientists informed.

Offshore Wind Energy Farms

India is also taking rapid strides in the field of sustainable and renewable energy. It is all set to become the third biggest solar energy market after China and US by 2018. A new and emerging source of green energy is offshore wind energy which is expected to generate 100GW of power annually. The first offshore wind farms will come up in Gujarat and Tamil Nadu by 2018. Later, more such wind energy farms would come up in 54 locations in the oceans surrounding India, of which the first structure will be installed by the end of January this year in the Gulf of Kutch, Gujarat, said Dr. Rajesh Katiyal, Deputy Director General, Offshore Wind and Industrial Business, National Institute of Wind Energy. The offshore wind farms located in oceans encounter less turbulent but higher speed winds, and offer more potential to generate power, compared to wind farms that are located on land.

In Asia, Japan and China have harnessed energy from offshore wind farms and India is set to join the league. At present, the offshore national policy enables any manufacturer to set up turbines up to 12 nautical miles from the coast to harness ocean wind energy to generate power. This could later be extended to permit setting up offshore wind farms close to international borders up to 200 nautical miles from the seacoast. Presently, this technology is expensive costing Rupees 18 crore for installing a single unit, which amounts to Rs 8 per kilowatt-hour of power. In the future, the costs are expected to come down after improving the installation and design of power plants.

Nanotechnology Finds New Applications

Early investments made by India in nano science and technology have begun to yield results. Nanotechnology research at academic institutions like IITs has provided new and cheaper devices for medical diagnostics, improving agricultural practices, and combating terrorism.
A glimpse of this was provided by Professor Ramgopal Rao, Director, IIT Delhi, who till recently worked at IIT Mumbai. Researchers at IIT Mumbai have developed a cardiac diagnostic device called iSens that would cut down the cost of detecting a heart attack to less than Rs 100 per test. In a routine setting, after a patient arrives in the clinic, it takes at least 4-6 hours for a blood test to confirm if the patient needs a treatment for heart attack. Now, with iSens, a nurse can detect a heart attack in less than 10 minutes, which would help patients receive medical care well in time. The device needs to be tested in clinical settings, for which IIT Bombay is setting up a prototype manufacturing facility located on its campus. This unit is expected to manufacture prototypes in large numbers for clinical trials.

Researchers at IIT Bombay are also working to develop devices for agricultural applications. They have developed a device for detection of soil moisture. The technology has been transferred to the Indian Agricultural Research Institute, which will help prevent wastage of water during irrigation. Another device called SoilSens detects the nutrient content of soil and has been developed by four Ph.D. students of IIT-B. This device is expected to help farmers use correct and kind of fertilizers, that is, practice ‘smart agriculture’.

By April 2017, a new device that can detect explosives like RDX and TNT is expected to enter the market, which will help prevent damage to loss and property due to terrorist attacks. These new devices will make Indian research competitive and sustainable but we still need more such sensitive and specific equipment to meet everyday needs and challenges.

Nobel Laureates become Youth Icons
The Indian Science Congress provided a platform for students to interact with Nobel laureates. All the Nobel lectures were well attended and were followed up by lively question-answer sessions. Young students were excited to meet their science stars and rushed to click selfies with them, before and after the lectures.

Professor W. Moerner, 2014 Nobel Prize winner for Chemistry, described how something impossible – viewing 10nm-sized single molecules in cells with super high resolution – was made possible by single molecule fluorescence microscopy. Single cell super-resolution microscopy is important to study the behaviour or dynamics of individual molecules in cells that could be totally different from an ensemble effect of all the molecules in the cell. This could also be used to detect dynamic movement of molecules in living cells, their localisation and even interaction with other molecules.

The Nobel Prize awardee 2015 for Physics, Professor Takaaki Kajita, delivered an engaging lecture on his
finding that neutrinos have mass. His finding refuted the well-established model of an atom taught in every single textbook across the world. 

According to the standard model of an atom, three types of very small particles (electron, proton, and neutron) make up all molecules. In addition to these three particles, an elusive particle called the neutrino was accepted to be massless.

In the Super-Kamiokande detector, an experimental facility in a mine in Japan in 1998, Takaaki Kajita detected neutrinos created in reactions between cosmic rays and the Earth’s atmosphere. Measurements showed deviations, which were explained by the neutrinos switching between the different types. This proved that neutrinos have mass. The standard model was refuted and revised after this discovery, which has opened completely new avenues of research.

The Nobel Prize awardee 2009 for chemistry, Professor Ada E. Yonath shared her findings on the structure and function of ribosomes, which are protein factories inside the biological cell. She has elucidated the mode of action of nearly twenty antibiotics and found the structural basis for their specific action, thus paving a way for molecular drug design.

**Science & Technology in India: Future Perspectives**

Prof. R. Chidambaram, Principal Scientific Advisor to the Government of India; Prof. Ashutosh Sharma, Secretary, DST; Prof. M. Rajeevan, Secretary, Ministry of Earth Sciences; Dr. V. K. Saraswat, Member, NITI Aayog; and Dr. Satheesh Reddy, Scientific Advisor to Defense Minister discussed the government’s future perspectives on science and technology in India.

To accomplish future goals, the government has allocated more budget for S&T and announced new programmes to promote the participation of women in science. The Government is also promoting research in newer areas, namely, waste management, and clean energy from oceans.

Indian scientists and researchers face some challenges that demand immediate attention and resolution. We need to empower scientists and ease the process of doing science. We also need to connect academia, research institutes, and industry to promote commercialisation and bridge the gap between basic research and technology.

Indian science has ambitious plans, such as further exploration of the two poles - Arctic and Antarctic – after acquiring an exploration ship. This plan, however, may have to wait, as it requires more funds and interdisciplinary talent.

In the future, India will set up more observatories, and data collection and monitoring centres to predict, manage, and mitigate damage due to natural disasters. “We must improve severe and accurate monitoring systems in the next 3-4 years,” said Dr. M. Rajeevan, Secretary, Ministry of Earth Sciences.

India may also become a world-class hub for defense research and development in the near future. “India needs to produce state-of-the-art goods and sell them to global markets, and redefine roles of academia and industry,” said Dr. Satheesh Reddy, Scientific Advisor to Defense Minister, Government of India.

With participation from over 18,000 scientists, researchers and students, the Indian Science Congress was indeed a platform to discuss and celebrate science, to inspire young minds to pursue research, to acknowledge the contribution of women in science and nurture their growth, and create an atmosphere that promotes innovation and translational research enabling holistic national development.