VIPNET CURIOSITY

VIPNET NEWS—VIGYAN PRASAR NETWORK OF SCIENCE CLUBS

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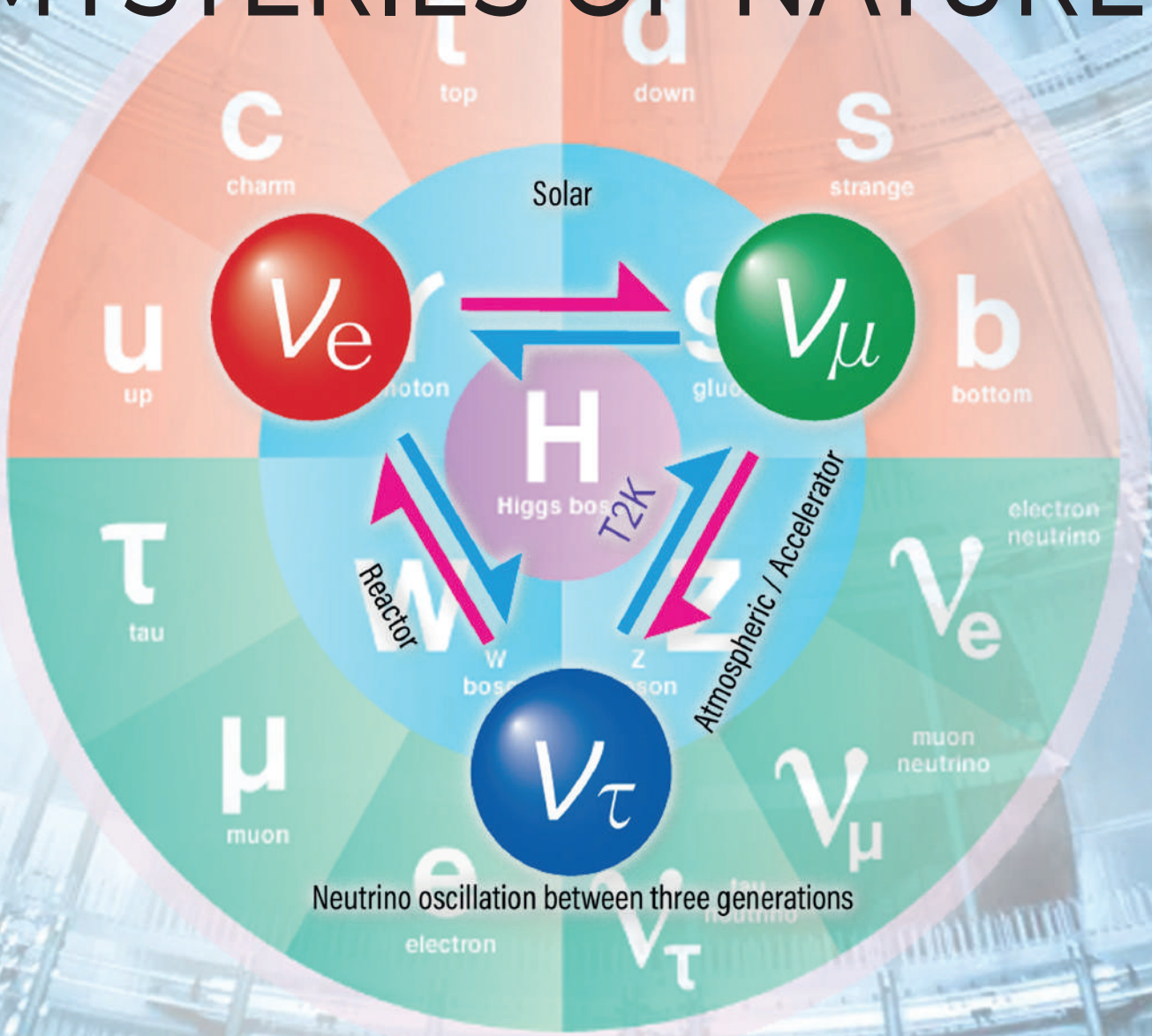
NEUTRINO: UNRAVELLING THE MYSTERIES OF NATURE



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EDITORIAL

K.B. Bhushan

New VIPNET Online Portal is OUT!

Vigyan Prasar NETwork of Science Clubs (VIPNET) was initiated with the aim to disseminate and engage with organisation/clubs working in the domain of science for an interactive outcome. Over the years it has developed a nation-wide network of active science clubs, societies, and organisations that have been participating in inculcating scientific temper among the masses. So far, VIPNET has registered 3,494 clubs, dotted among all the regions of the country. We are also delighted with the responses that we have received across the country in our initiative to re-register the clubs. Till now the website of VIPNET was a part of the main Vigyan Prasar website. But now we have a separate web portal for VIPNET with an URL www.vipnetscienceclubs.in. It has several unique features. Now you have the opportunity to join our national network and break the physical and cerebral hindrances of being an isolated, small unit. It would let your club access communication materials provided by Vigyan Prasar. The website of VIPNET not only enhances the chances of networking by connecting with other clubs but also in spreading useful information.

We have created a seamless website registration process for the users to join the network of science clubs. The web portal will be accessible by all, irrespective of the device they use, technology, or ability. Once you have entered the VIPNET web portal domain, all you have to do is to click on the 'Join Us' link, which will take them to the 'Start a Club' page. In this page you would find the eligibility criteria and guidelines for registration. Further scrolling down the page will take you to the 'Join Us' section. Click the button to lead to the "Registration Form". Fill in the details and submit the request by clicking the 'Register' button. The account then will be created and the club can now submit their activity report by entering the login credentials into "www.vipnetscienceclubs.in/login". Once logged in, the club will have to opt for 'Activity Report', fill up all the necessary details, and then submit the report.

Each registered/re-registered club will be given a White Club membership, and later, based on the frequency of their reports, the clubs will be promoted to various categories on the web portal of VIPNET. VIPNET website has been developed to provide maximum convenience and usability to its users and further rationalise the engagement to expand the activities of the network. More explicitly, all the clubs receive its monthly newsletter named "VIPNET Curiosity", which provides a remarkable platform for the clubs to exchange perspectives and ideas, convey opinion, and gain insight(s) into a wide array of topics involving science and technology. We appreciate the work of our active and vibrant clubs. Vigyan Prasar is in the process of framing policies to strengthen the VIPNET clubs through consistent feedback and continuous programme delivery. Join us to make a better future for the nation and the Mother Earth!

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Neutrino: Unravelling the Mysteries of Nature

Mahima Sachdeva

...The earth is just a silly ball
To them, through which they simply pass
Like dust maids through a drafty hall...

-- John Updike

Coldplay got the emotions right, "look at the stars, look how they shine on you"! Yes, it was all yellow. The Sun burns and keeps the Earth warm and powers the life in it. Ancient philosophers proposed the theory of everything being confined in five elements – Earth, water, fire, air (vaayu) and space (akash). Experimental evidence is what differentiates the ancient philosophers from the present-day scientists. With meticulously designed experiments in the 20th century, physicists have discovered the elementary particles which make up the universe. The Standard model describes the elementary particles – the smallest building blocks of the universe. Electrons, protons, neutrons, neutrino, muons, positrons... do you really want me to name all these guests of ours? Some of these particles are more familiar to us – especially the electron which revolves around a ball-like structure within the atom and later it was found that this mass constitutes of neutrons and protons that are made up of 'up' and 'down' quarks (elementary particles).

Some of these other particles are zipping through us right now – neutrinos, muons, etc. at speeds close to that of light. These particles are produced at the upper atmosphere when cosmic rays (protons, alpha, Li+ etc.) collide with the air molecules. The collisions result in a shower of secondary cosmic particles.

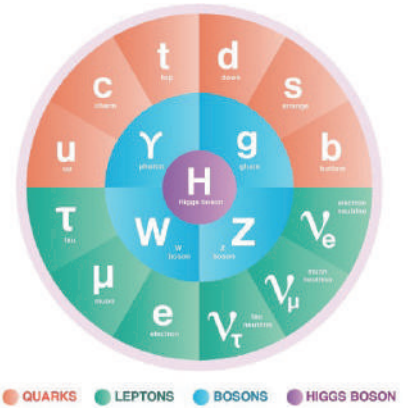
Can we see these secondary cosmic particles? Not with our naked eyes!

Neutrinos are both mysterious and omnipresent. They are one of the most abundant particles in the universe, passing through most matter unnoticed. Billions of them are currently flowing through our body harmlessly. There are around 700 million neutrinos in the universe for every proton. According to some scientists, neutrinos are to be blamed for the absence of antimatter in the universe after the Big Bang, which resulted in it being dominated by matter. So, in order to understand the universe, we must first understand the neutrino.

The process of thermonuclear fusion causes the Sun to shine. In its core, the Sun produces helium from hydrogen to produce light and heat. Neutrinos are required to conserve energy, momentum, and angular momentum. **Without neutrinos, the Sun would not shine**.

Neutrinos

A neutrino is a tiny elementary particle that resembles an electron in many ways but differs in that it does not have an electrical charge and has a very small mass. Once produced, these spooky particles hardly ever interact with other types of matter. Although mass is a fundamental attribute of matter, there is still much we don't know about it, particularly when it comes to neutrinos' unusually small masses. The Standard Model of Particle Physics is the best explanation available to scientists at the moment to explain the universe's most fundamental building blocks. But, only around 5% of the universe can be explained by our best particle physics model; and it says that neutrinos should not have any mass, just like photons. They traverse at speeds nearly close to that of light, so close that because of a bad cable connection during a neutrino experiment at Italy's Gran Sasso National Laboratory in 2011, it was briefly thought that they might be the only known particle in the universe that travels faster than light.



The Standard Model of Particle Physics: The matter particles (quarks and leptons), force-carrying particles (bosons), and the Higgs boson
[Image Courtesy: Symmetry Magazine, a joint Fermilab/ SLAC publication. Artwork by Sandbox Studio, Chicago]

Neutrinos are a part of the lepton family in the standard model of fundamental particles and they are subjected

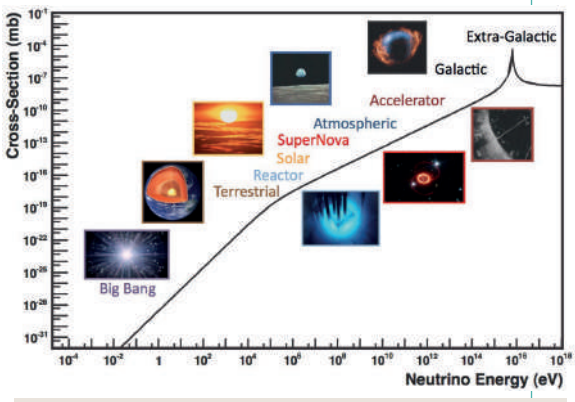
to weak interactions out of the four fundamental forces of nature. Leptons are any subatomic particles that are unaffected by the strong force and only react to the electromagnetic, weak, and gravitational forces. Since leptons don't seem to be composed of other particles, they are categorized as elementary particles. Leptons have two possible states: neutral or carrying one electric charge. The charged leptons are electrons, muons, and taus. These different varieties each have a distinct mass and a negative charge. The electron, the lightest of the leptons, has a mass that is just 1/1,840 that of a proton. With a mass more than 200 times that of an electron, muons are noticeably heavier. On the other hand, taus have a mass that is around 3,700 times that of electrons. Each of them has an associated neutrino. Thus, neutrinos (e.g., electron-, muon-, and tau-neutrinos) are the neutral counterparts of each charged lepton. All leptons, including neutrinos, have antiparticles called antileptons. While the antileptons' other characteristics are reversed, they share the same mass as the leptons.

The idea of the neutrino

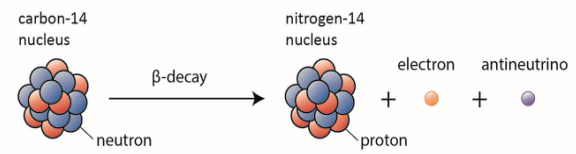
Neutrinos were predicted back in 1930, but their existence wasn't even confirmed until 1956 due to their elusive characteristics. Wolfgang Pauli first proposed the neutrino in order to explain the apparent loss of energy and momentum that he noticed while researching radioactive beta decays, the process by which certain radioactive atoms break down. The term 'neutrino' was coined by Enrico Fermi in the year 1934.

Where do neutrinos come from?

It appears that neutrinos come from almost everything. The stars, the sky, bananas, and human beings all produce neutrinos. They originate from a variety of sources with different energies. Neutrino sources can be either natural or artificial. Natural sources of neutrinos include those from the Sun (Solar neutrinos), the Earth's atmosphere (Atmospheric neutrinos), the planet's core (Geoneutrinos), neutrinos from the Big Bang (Relic neutrinos), as well as Active Galactic Nuclei (AGN) and Gamma ray bursts (GRB) neutrinos (High energy cosmic neutrinos). We can create neutrinos in our laboratories as well, such as accelerator neutrinos from pion and muon decay and reactor antineutrinos from nuclear power plants. A neutrino is more likely to interact the more energy it possesses.



Depiction of neutrino sources based on the energy
[Image Courtesy: J.A. Formaggio and G.P. Zeller; https://neutrinos.fnal.gov/types/energies/]



An example of β+ decay is the decay of Carbon-14 into Nitrogen-14
[Image courtesy: https://nuclear-power.com/wp-content/uploads/2015/03/Beta_Minus_Decay.png]

Solar Neutrinos

The most prevalent kind of neutrino travelling through any source observed on Earth at any given time is a solar neutrino, which is a neutrino produced by nuclear fusion in the Sun's core. The proton-proton chain is responsible for the majority of the contribution.

$$p + p \longrightarrow d + e^{+} + \nu e$$

About 91 per cent of the solar neutrinos are generated by this reaction.

Atmospheric Neutrinos

Around 15 km above the surface of the Earth, atmospheric neutrinos are typically created when an energetic space particle called a cosmic ray collides with the atmosphere of Earth. In the atmosphere, muon neutrinos and antineutrinos make up around two-thirds of the total amount of neutrinos, while electron neutrinos and antineutrinos make up the remaining third.

When were the neutrinos discovered?

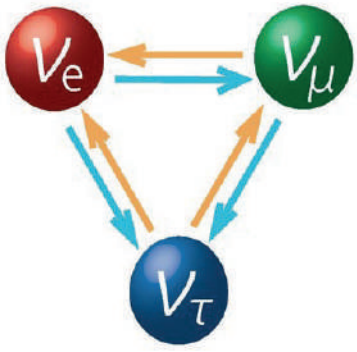
The Cowan-Reines neutrino experiment confirmed the existence of neutrinos in the year 1956. Finally, the ghost was captured by the researchers using a nuclear reactor, an exceptionally dense source of neutrinos. They used a 10-ton detector set up near to a fission reactor at the Savannah River Plant for five months to gather data. Frederick Reines and Clyde Cowan jointly detected the neutrino in

An illustration of Cowan-Reines neutrino experiment set-up
[Image Courtesy: https://cerncourier.com/a/ghosts-in-the-machine/]

the neutrino experiment that earned them the 1995 Nobel Prize in Physics.

Do they have mass?

Neutrinos were supposed to have no mass at all according to the Standard Model of Physics; but experiments conducted around 24 years ago revealed that they do. For many years, scientists believed they had no mass. There are three flavours of neutrinos: electron neutrino, muon neutrino, and tau neutrino. And, they can change their flavour when they travel via a process called Neutrino Oscillations. In 1998, the discovery of neutrino oscillations was asserted. In this a neutrino slowly changes from one kind to another as it travels. Neutrino's absolute mass is still unknown, despite experiments demonstrating that they can change type proving that this isn't the case. Every neutrino is a quantum superposition of all the three flavours. A neutrino's likelihood of being electron flavoured, muon flavoured, or tau flavoured varies with its energy and the location on its path where it is caught. For example, the Sun produces electron neutrinos. By the time they reach the Earth, majority of them have turned into either muon or tau neutrinos. And, this is only possible if they have non-zero mass. The theory of neutrino oscillations was hypothesized by Bruno Pontecorvo in 1957.



Demonstration of neutrino oscillation [Image Courtesy: https://blogs.voanews.com/science-world/2013/07/23/neutrino-morphing-discovery-could-unlock-mysteries-of-the-universe/]

First evidence of neutrino oscillations

The first evidence of neutrino oscillations, which suggested that neutrinos must have mass, was announced by the Super-Kamiokande collaboration in 1998. In order to explore the numerous physics phenomena, the Super-Kamiokande experiment in Japan used a massive underground detector filled with ultrapure water. The experiment demonstrated that certain atmospheric muon neutrinos vanished as they made their way to the one-kilometer-deep detector, oscillating into another flavour.

Furthermore, the Sudbury Neutrino Observatory (SNO), located in Ontario, Canada, discovered in 2002 that electron-neutrinos released by nuclear reactions in the Sun's core undergo a flavour change as they travel through the Sun. Such "oscillations" of neutrinos are only feasible if one or more neutrino types have some small mass. The 2015 Nobel Prize in Physics was awarded jointly to Takaaki Kajita and Arthur B. McDonald for the discovery of neutrino oscillations.

How much do they weigh?

Experiments revealed that neutrinos have mass and three of its different flavours have different masses. The sum of all three of those types is still less than one millionth the mass of an electron. But, the exact value of any of these masses is yet to be measured.

Catch them if you can!

Since they have no electric charge, neutrinos only interact using the weak nuclear force, unlike the other particles. They can pass through enormous things without engaging with them because the weak nuclear force only interacts with matter at short distances. They're extremely difficult to catch. Tens of billions of solar neutrinos pass through our body every second, but we cannot feel them. In that way, they seem a bit like ghosts. But it's

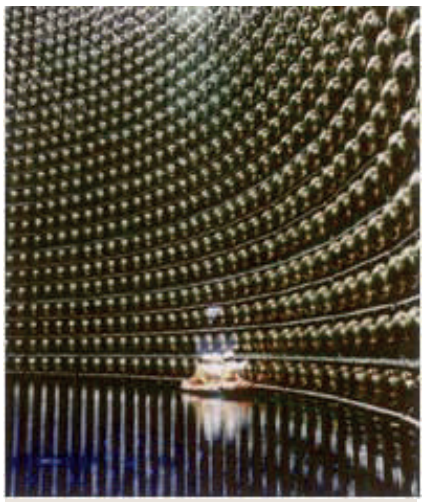


Illustration of Super-Kamiokande experiment setup [Image Courtesy: https://www.fnal.gov/pub/inquiring/timeline/27.html]

crucial to understand these particles because they could hold the key to unravelling some of the universe's greatest riddles, such as what's happening inside the heart of stars and galaxies or why the universe exists.

How to catch them?

If a glass of water is placed on a table, a trillion neutrinos will pass through every second. The majority of these esoteric species pass through quietly without leaving a mark. However, a neutrino will occasionally, perhaps once every ten million trillion times, strike one of the atoms that make up a water molecule. This unusual interaction could produce a tiny flash of light or leave some free electric charge. It's impossible for human eye to observe this flash. But these little signals can be picked up by the sensitive detectors built by the scientists and can be amplified by the electronics inside so as to make the inconspicuous "ghosts" visible, a ghostbuster!

Can you tell an example of a natural detector?

Giant detectors are needed to catch enough neutrinos to learn anything about them. Say a big-

ger "glass of water"—vast tanks filled with millions of gallons!

Numerous detectors have been built and are planned to catch these phantoms and investigate their various aspects. In 1968, a detector in the Homestake mine in South Dakoda attempted to detect electron neutrinos from the Sun for the first time. The list of neutrino experiments, neutrino detectors, and neutrino telescope is non-exhaustive.

Illustration of Ray Davis Homestake Experiment [Image courtesy: http://www.sns.ias.edu/~jnb/Papers/Popular/JohnRaypictures/johnraypictures.html]

India's plan to bring neutrino science home

The atmospheric neutrinos were first detected by Kolar Gold Field Experiment (KGF) in India and almost simultaneously by an experiment led by Fred Reines in South Africa in the year 1965. India is working on a mega science project to build a neutrino observatory to detect the neutrino particles and to understand their properties and a mini version of the same is already there in a place named Vadapalanji, just an hour drive from Madurai.

India-based Neutrino Observatory

The India Neutrino Observatory (INO) Project, a multi-institutional initiative, intends to build a world-class underground laboratory in India for high energy and nuclear physics research without the use of accelerators. It has a 1200-metre thick rock cover. The project is jointly funded by the Department of Atomic Energy (DAE) and the Department of Science and Technology (DST) of Govt. of India.

The main aim of INO is to study neutrinos. Determination of neutrino masses and mixing parameters is one of the most significant open challenges in physics right now. The Observatory will house the 50-kt magnetized iron calorimeter (which measures energy) detector. The magnetized ICAL will be made up of more than 50,000 tonnes of 56-mm-thick iron plates stacked with gaps in between, where about 28,800 Resistive Plate Chambers (RPCs) of 1.95m x 1.92m dimension will be inserted as active detectors. This upcoming detector will study atmospheric neutrinos and antineutrinos individually over a wide range of energies and path length, which will address some of the key challenges in neutrino oscillation physics - a novel way including the neutrino mass hierarchy or neutrino mass ordering.

The ICAL experiment primarily focuses on measuring the energy and zenith angle dependency of the atmospheric neutrinos in the multi-GeV range in order to explore the Earth's matter effect. This gigantic detector will have the ability to identify the charge, hence neutrinos can be distinguished from antineutrinos at GeV energies and its direction as well.

Mini-ICAL: The prototype detector

In order to gain experience in the construction of a large-scale electromagnet, to analyse the performance of a detector, and to test the ICAL electronics in the presence of fringe magnetic fields, a mini-ICAL (prototype detector) has been built and installed at INO transit campus in Madurai. This is 50 times scaled down version of the ICAL detector. It weighs 1/600 of the weight of the ICAL. This 4m × 4m × 1.1-m detector has 11 iron layers and 20 RPCs of 1.95m × 1.92m have been inserted in the 10 layers of gaps in the central region and has been collecting cosmic ray muon data since 2018.

Mini-ICAL, a prototype of ICAL detector at IICHEP transit campus, Madurai

Applications

A world without technology today is unimaginable. This invisible particle might serve as the foundation for incredible novel technologies. Therefore, research in basic sciences is required to comprehend the characteristics of particles before they can be applied. It is possible for neutrinos to detect nuclear weapons, speed up global communication, and even corroborate the existence of elusive dark matter. Since these particles can pass through anything without interacting, it would be easy to communicate with submarines submerged far below the surface with them. In addition to the immediate applications of neutrinos, there are some technological applications of the detectors that will be utilized to study them. We must not forget that development of X-ray machines, PET scans, MRI scans, etc., all began with particle detectors' research.

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The Sun and the Shadows

T. V. Venkateswaran

Teachers have a penchant for asking questions – right? So let us start with one. A simple one to which most of us will have an answer.

Where does the sun rise?

Ah, you think. This is a trick question. With glee on your face, perhaps you are saying, the sun does not rise, it is just that the earth revolves around its axis and so the sun appears to rise and set.

Well, well. Let me change my question. Where does the sun appear to rise?

You are probably trying to figure out the catch in this question, but surely in some corner of your mind you (at least most of you) thought of 'east'.

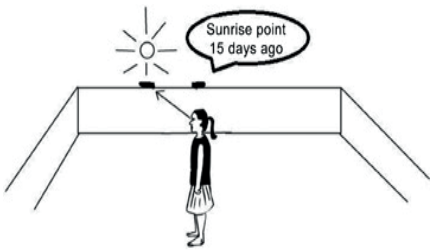
We teachers like difficult and tricky questions.

The sun does not appear to rise in the east, except for two days in a year. The point of sunrise is either northeast or southeast for all the other days!

A simple activity will help clarify this point.

Choose a spot on your terrace with an unhindered view towards the east and mark it. You will have to stand on that spot many times during this exploration, therefore make the mark durable. Watch the sun as it rises above the parapet wall. Ask your collaborator to place a stone on the parapet wall such that the pebble and the rising sun are in a straight line. Come back to the same spot, say after 15 days. Watch the sunrise.

Surprise! The sun is not rising at the point marked by the stone on the parapet wall. Once again, ask your collaborator to place another stone at the point where you, the stone, and the rising sun are in a straight line. Do not remove the first stone, let it be there at the same spot; write down the date on which these observations were made below the stone on the parapet wall. Repeat this activity every 15 days. You may not be able to observe the sun rise every 15 days. Some days, the sun may be covered by clouds, some days it may be raining heavily, but it is ok. Observe and mark the spot with a stone as many times as you can.



Sunrise point changes every day
Images courtesy: T V Venkateswaran

If we make an effort, we can find that successive sunrise points are moving towards the southeast for six months and towards the northeast in the next six months. The southeast position is closer to December 21 (winter solstice), and the northernmost place is closer to June 21 (summer solstice).

Further, we can find that the sunrise point is very close to the actual east on two days in a year – the equinoxes.

Shadow time

If I ask you what the time is now, you will either look at the clock in your mobile phone or the clock on the wall. Imagine a time when there were no mechanical (obviously no electrical or electronic) clocks. How did people tell time? By studying the length of their own shadows!

I come from Tamil Nadu and there is an old verse in Tamil that tells one how to compute time from the length of one's shadow. Choose a rock, telegraph pole or the edge of a pavement as the mark. Adjust yourself such that the shadow of your head kisses the edge of the stone/telegraph pole/pavement. Measure the length of your shadow with your feet by walking towards the stone/pavement.

In the olden days, in the southern part of India they used a time division called 'nazhikgai', which is equivalent to 24 minutes. From sunrise to sunset, there were 30 nazhikgais. If your shadow length is 98 feet measure (by your feet! This is important, remember), then from sunrise, it is not more than one 'nazhikgai' (or 24 minutes). If it is afternoon and the shadow is pointing towards the east, then a 98 feet long shadow indicates that sunset will occur in less than 24 minutes. If the shadow length is 45 feet, it is two nazhikgai (48 minutes). The table below gives the shadow length measured with our feet and the corresponding time since sunrise (or time remaining for sunset) according to the old Tamil verse.

Length of the shadow (in your feet measure)	Corresponding time measure
98	1
45	2
28	3
19	4
14	5
10.5	6
8	7
6	8
4.5	9
3.5	10
2.5	11
1.75	12
1	13
0.5	14
0	15

This works roughly for Tamil Nadu; I am not sure this will work just the same in your place of residence. Why not try measuring shadow lengths? Prepare a table for your area using the shadow measurement given above.

The setting sun

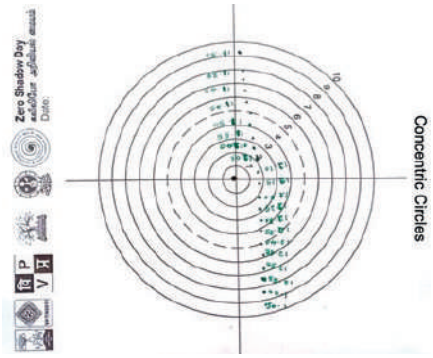
Now let's look at how long it will take for the sun to set. Go out or stand in a place where you can see the sun without any hinderance. Now stretch out your hand. Turn your palm in such a way that it is facing you. Align your index finger to the bottom of the sun by keeping the fingers parallel to the horizon (as shown in the image). If there is still space between the palm and the horizon, use the fingers of the other hand as well (see image). Measure the distance between the setting sun and the western horizon with your fingers. If the sun appears to be six fingers above the horizon, it will take one hour and 30 minutes for the sun to set; for every finger, approximately 15 minutes.

Is it really afternoon?

When is it 'noon'? When the clock shows 12:00, we say. However, this is not the 'astronomical noon', the time at which the sun crosses the meridian line at one's place of residence. So how can one find the astronomical noon at their place? And why does the astronomical noon differ from the clock noon?

If you have access to an open space, place a vertical pole and draw a circle on the ground with the length of the pole as the radius. Observe the shadow cast by the pole, say from 11:30 am to 12:30 pm, marking on the ground the length of the shadow every 10 minutes. Create a graph with the size of the shadow on the Y-axis and the time on the x-axis. The time at which the shadow is the shortest is the local noon or astronomical noon.

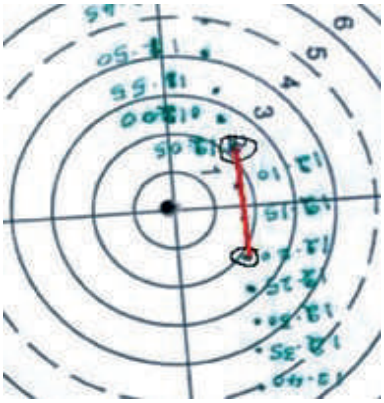
Another way to perform the same experiment is by constructing a gnomon. Draw concentric circles on a paper (as shown in the image below) and place a vertical pole (pencil) at the centre. Note the shadow point of the tip of the pencil every five minutes. When two points fall on the same circle, add the clock time of these two points and divide by two; we get the astronomical noon. In the above image, the shadow of the pencil tip falls on the second circle twice at 12:05 pm and 12:20 pm. Add them 12:05+12:20 and divide by two. We get ~12:12; this is the astronomical noon at the location where this observation was made.



Pencil tip shadow markings with timings

The Indian Standard Time (IST) is relative to 82° East longitude in India. Therefore, east of this longitude, the sun will cross the meridian much earlier than 12:00. West of this longitude, the sun will cross the meridian after 12:00.

The gnomon can also be used to find the cardinal directions. Suppose you draw a circle with the pole as the centre. Before the astronomical noon, the shadow will touch the circle at a point and after the astronomical noon at another point along that specific circle. Join these points, that line is west-east (see image). You get the north-south line with the pole as the centre to bisect the west-east line. For example, in the image, points related to the shadow at 12:05 and 12:20 are on the second circle; joining them gives us the west-east line and bisecting them provides the north-south line.



Line joining two points on a circle where the shadow of the pole falls is the west-east line. Line perpendicular to it gives the north-south line. In the above image, at 12:05 and 12:20 the shadow toched the second concentric circle. The line joining the same is west-east line.

Keep observing the gnomon shadows at the instance of astronomical noon every day. You will find an interesting phenomenon.

In Chennai, from August 18 to April 24, the pole's shadow will be towards the southern direction. On April 25, the direction of the shadow will be west-east. At astronomical noon, there will be no shadow – zero shadow day! However, on April 26, the shadow will be pointing north! It will point towards the north until August 16. On August 17, the shadow will be west-east and at noon, no shadow. Once again, zero shadow day. From the next day, August 18, the shadow of the vertical pole flips to the southern direction.

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To Ease Chemistry for Students through Activities

Ranjana Agrawal

Many of our day-to-day activities are based on the principles of chemistry. Many things that happen around us are the result of a chemical reaction of some sort. Such examples of chemical experiments are quite prevalent in biological and environmental systems. Chemistry, as everyone knows, is concerned with chemicals. Chemicals are found in everything, including our bodies and the environment (air, water, soil, and so on). Even the diverse emotions we experience are the result of neurochemicals released in the body.

Chemistry involves substances, matter, activities, reactions, ions, and much more. As a subject chemistry is often regarded as difficult, technical, and occasionally boring by students as it involves memorizing long reactions, equations, complex mechanisms and concepts, difficult names, etc. However, chemistry can be made easier and more interesting if it is taught with the help of activities rather than cramming mindlessly. Various chemistry concepts that may be difficult to understand through theoretical lectures might be clarified with the use of practical activities.

These activities will spike interest among students in the subject and will also improve their understanding. These exercises should be done in groups to help children acquire leadership qualities, collaborative skills, and improving understanding of the practical application of chemistry in everyday life.

Here are some activities that children in the age group of 10 to 15 may carry out to boost their interest and involvement in the subject.

Bouncing egg activity

In this activity an egg is placed in a bowl filled with white vinegar and is left at room temperature for around 3-4 days. It is found that after that the egg becomes bouncy and translucent in its appearance and is no more fragile as it used to be earlier.

A chemical reaction between the eggshell and the vinegar causes the egg to become bouncy. Egg shells contain calcium carbonate. The vinegar acts as a weak acid and produces CO_2 as a gas that forms bubbles. When we wash the egg shell after 2-3 days, the vinegar permeates the selectively permeable membrane of the egg by osmosis, causing the egg to swell and become bouncy.

This experiment teaches two basic concepts:

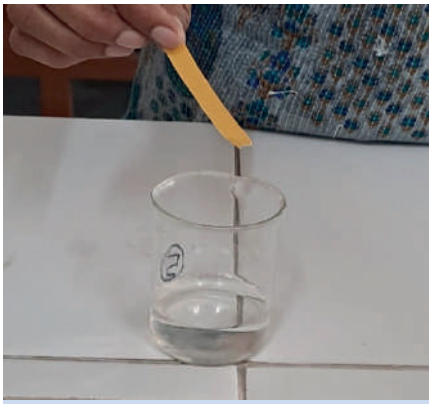
i. Interactions between $CaCO_3$ and vinegar produce CO_2; and

ii. How a liquid (vinegar) flows across a semi-permeable barrier from a higher concentration to a lower concentration.

The pH indicator experiment

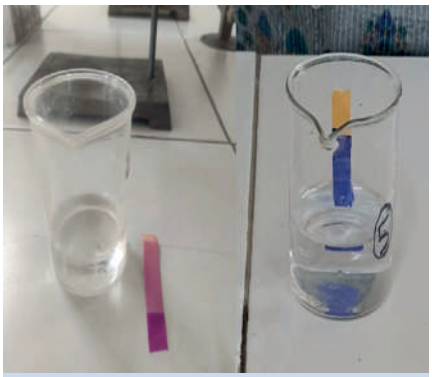
This is another intriguing activity for understanding the concept of acidity and basicity of elements. A pH strip is dipped in a solution of a particular material and the colour of the strip changes. If the colour changes to red, the solution is acidic; if it changes to blue, the solution is alkaline; and

Egg turns Bouncy



Plain pH strip

A) Unadulterated Ghee B) Adulterated Ghee



In Acidic Solution In Basic Solution

A) Uniodised Salt Sample B) Iodised Salt Sample

if there is no change, the solution is neutral. To demonstrate the acid-base properties we use solution of tomato juice, washing soda, vinegar, and a variety of other common ingredients.

Checking adulteration of food items

Modest chemistry experiments can be used to check for adulteration in various food items and can be explained to students. For example, presence of colour in ghee (fat) can be determined by mixing it with H_2SO_4 in a test tube. If the ghee is contaminated, it would turn into pink.

Similarly, it can be easily checked if the salt is iodized or not. Chop a potato, sprinkle some salt to be tested over it, wait for a few minutes, and then pour some vinegar over it. If the colour of the salt turns blue, the salt has iodine in it.

Different liquids such as water, honey, dish soap, coloured solution, vegetable oil, etc. can be taken individually and then poured gently into a glass tube one by one to demonstrate the concept of density. According to their density, the liquids will sink down in the glass. The lighter ones would float over the heavy liquid, if they are not miscible. And would form different coloured layers.

More such experiments can be thought of and performed after going through each chapter in the class so that students remember them and can correlate with the lesson taught.

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VIPNET ACTIVITY STARS!

QUIZ ON MAYFLIES

1. **Nikon Kalundia**
   Aayub School, Vill. Pandrasali,
   P.O- Bara Lagra, P.S- Manjhari,
   Dist. West Singhbhum,
   Jharkhand, India

2. **Deepanshi Sharma**
   16A Kehar Singh Nagar, Badi Haibowal,
   Jassian Road, Ludhiana, Punjab

3. **Mani Gupta**
   FCA-205, Jain Colony, Ballabgarh,
   Faridabad, Haryana 1210

Answer of Curiosity June issue Quiz on Mayflies

1. b 2. a 3. c 4. d

JIGYASA: A Student-Scientist Connect Initiative by CSIR

Manish Mohan Gore

Curiosity is the mother of all sciences because the word 'science' itself is derived from Latin word 'Scientia' which means 'to know'. Children are born with inherent curiosity. Subsequent learning, experiences, and surroundings help in shaping their personality. Often, the parents, teachers, or a person come in their life and motivate them in exploring new ideas/situations.

'JIGYASA' is one such unique initiative that helps in nurturing young minds with scientific learning and research. It aims at the development and enhancement of inquisitiveness among children about science and technology. This initiative was taken up by Council of Scientific & Industrial Research (CSIR) at national level in 2017. This largest scientific organization of India is widening its Scientific Social Responsibility (SSR) further with the JIGYASA programme.

> **"Curiosity is the single most important attribute with which humans are born. More than a simple desire to discover or know things, curiosity is a powerful tool, like a scalpel or a searchlight. Curiosity changes us. It is also a way to effect change, perhaps even on a global level."**
>
> -- Loren Rhoads

Inspired by the Hon'ble Prime Minister's vision of new India and SSR, CSIR launched the student-scientist connect programme 'JIGYASA' in collaboration with Kendriya Vidyalaya Sangathans (KVS) on 6 July 2017. The sole objective of this initiative is to extend the classroom science leaning and to focus on a well-designed R&D laboratory-based learning.

CSIR and KVS had signed an MoU for this unique initiative. In this platform scientists and teachers would nurture young minds in the domains of S&T. School children would be visiting the national scientific laboratories and research institutions in order to get an opportunity to interact with scientists working in the laboratories and come across the ambience, scientific instruments, and facilities at the laboratory. This would also enable the students and teachers to indulge in hands-on practical activities to test the theoretical concepts taught at the CSIR laboratories and by participating in mini-science projects organized there. Since the inception of the programme, nearly 981 events have been conducted by CSIR laboratories. More than 3 lakh school students and 15000 teachers participated in various engagement modules by visiting CSIR Labs till the beginning of the pandemic in 2020.

Several collaborations and linkages have been developed to widen the horizons of exploring S&T through lab visits and hands-on activities among students. Beyond KVS, other educational bodies are reaching out to CSIR for more activities. Many CSIR laboratories have signed MoU with Navodaya Vidyalay (NVS), Karnataka State S&T Academy (KSTA), Atal Innovation Mission (AIM), Niti Aayog, IIT Bombay (IITB), several 'NGOs', stakeholders, individuals etc.

A Letter of Intent (LoI) has also been signed by CSIR with AIM on 5 June 2020 to connect Atal Tinkering Lab (ATL) with Jigyasa. During the COVID-19 pandemic, when schools were closed and students became dependent on virtual classes, a weekly webinar for school students was initiated by CSIR-AIM, in collaboration with ATL and Jigyasa. A YouTube Channel has been recently been launched by CSIR Jigyasa that has more than 10000 subscribers. CSIR adopted 249 ATLs by joining hands with AIM-Niti Aayog.

Role of science and scientists to overcome myths related to COVID-19 in common public; Drugs discovery; Vaccines; Clinical aspects and Technologies combating COVID-19; etc. were discussed in the webinars.

The series was successful in attracting the attention of a large numbers of students across the country. These webinars allowed direct interaction of students with the scientists and inculcated inquisitiveness by asking questions. The series had a massive reach and presence on various social media platforms.

This series has been restarted by

CSIR and NITI Aayog and is now positioned as "Demystify Science Series" as a part of 'Azadi Ka Amrit Mahotsav' initiative. As the name indicates, the webinar series is expected to demystify various myths and provide a scientific perspective to children enabling think logically and become a responsible citizen.

Modes of Engagement with JIGYASA

Learning by doing is the core philosophy of Jigyasa. Since children learn most by doing things, Jigyasa envisages some of the following models of engagement:

- Laboratory Visit
- Popular Science Lecture
- Summer Vacation Events
- Scientists as Teachers and Teachers as Scientists
- Teachers' Workshop
- Student Residential Programme
- Visits of Scientists to Schools
- Lab-specific activities/ Onsite experiments
- Laboratory Foundation Day Celebration
- Important Awareness Days
- Sponsored Programmes for School Children
- CSIR Foundation Day
- National Technology Day
- Student Apprenticeship programme
- Science Exhibitions
- Science and Maths Club
- Projects of National Children's Science Congress
- Publications of student articles in CSIR Journals

Learning of Theoretical Concepts with Practical Experiments

In the school ambience, students mostly learn theoretical concepts of science and technology. But through Jigyasa, students get exposure to touch and operate the scientific instruments in a laboratory. They also interact with scientists and get to ask questions. This way, the programme inculcate the culture of inquisitiveness on one hand and develop scientific temper on the other among the students.

Science as Career Option

This programme also motivates students towards higher study in various streams of science. It inspires them to choose science as career option and do research in science. This is one of the best outcomes of the Jigyasa programme.

CSIR Virtual Lab: An Extension of CSIR Jigyasa Programme

CSIR has taken a step further by launching 'CSIR Jigyasa Virtual Lab (CJVL)', which emerged during the pandemic. During those unprecedented times, students could not visit the laboratories or meet the scientists. Hence our Hon'ble Prime Minister encouraged for developing a virtual lab so that science can reach to all segments of students from every corner of the country without any hindrance. Hon'ble Union Minister for Science & Technology Dr Jitendra Singh launched it on 22 November 2021.

A concept note was developed and a task force committee was set-up by the Director General of CSIR. A research survey was carried out by CSIR-National Chemical Laboratory (CSIR-NCL), Pune on the existing Indian and International virtual labs. A study was conducted on the National Education Policy and Science Technology Innovation Policy. In 2020, a six-month pilot phase was carried out by the CSIR laboratories for developing fun activities based on science for students. The software was developed by IIT Bombay (IITB) through an MoU signed between CSIR-NCL and IITB. The pilot phase of CJVL was successfully completed on 31 March2021

The fundamental objective of the CJVL is to create scientific models virtually and make them interesting to students so that they can engage with science by having fun. Students get free access to both the online and offline platforms. The platform of CJVL consists of dual potential - Jigyasa and Virtual lab that upgrade it to higher version 2.0. It aims to kindle the culture of curiosity, logical-cum-critical thinking on one hand and technology-oriented thinking and self-learning on the other.

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Why is 7 Lucky and why Plane Crashes are a Rarity?

Arkapravo Bhaumik

It is amazing to know how many people consider seven to be their 'Lucky' Number! This is also a basis for many myths and folklore in various cultures. But, mathematics also plays a part in it.

Consider a six-sided die which is used for playing Ludo and Snakes-and-Ladders. Employing two such dice we can generate a sum in the range of 2 to 12.

For example, a sum of 9 can happen with 4 in the first die and 5 in the second one or vice versa. Another option is to get a 3 in the first die and a 6 in the second one or the reverse. Of course we cannot consider combinations as 7 and 2, and 8 and 1 since the maximum number we can get is 6 in a single die. Therefore, the total ways to get to a sum of 9 are (4 in first, 5 in second), (5 in first, 4 in second), (3 in first, 6 in second) and (6 in first, 3 in second) - 4 ways. A similar exercise for a sum of 4 will give us 3 ways - (2 in each die), (3 in first, 1 in second) and (1 in first, and 3 in second). If we continue this exercise then we get the following:

2 = (1,1)
3 = (2,1) (1,2)
4 = (2,2) (3,1) (1,3)
5 = (4,1) (1,4) (3,2) (2,3)
6 = (5,1) (1,5) (3,4) (4,3) (3,3)
7 = (6,1) (1,6) (5,2) (2,5) (3,4) (4,3)
8 = (4,4) (3,5) (5,3) (6,2) (2,6)
9 = (4,5) (5,4) (6,3) (3,6)
10 = (5,5) (6,4) (4,6)
11 = (5,6) (6,5)
12 = (6,6)

We can see that 7 occurs the maximum number of times - 6 times out of total 36 options. Which means we have a percentage chance of 16.67% of getting a 7. Is this why 7 is lucky?

Such study of chances is known as probability and it forms an academic stream of higher mathematics. This discussion can be extended to playing cards, roulettes, and even to events occurring in our day-to-day life.

Image courtesy rawpixel.com (CC0 license)

To extend this discussion to games of cards, if we make an attempt to draw 4 cards one by one from a pack of 52 cards what is the chance that all four will be aces? In the first attempt to draw an ace, it can be done in 4 ways in a stack of 52 cards. In the second draw, assuming that the first one was an ace, it can be in 3 ways in a stack of 51 cards. In the third draw, assuming the first two were aces, it can be in 2 ways in a stack of 50 cards. In the final draw, we are left with one ace in a stack of 49 cards.

Therefore, to draw 4 aces the chances are,

$$\frac{4}{52} x \frac{3}{51} x \frac{2}{50} x \frac{1}{49} \approx 0.000003694$$

Which is less than 4 times in a million attempts – a ridiculously low chance. That is why quite often aces in a game of cards confirms the winner.

Other than games and gambling, the study of probability is essential for various businesses as well. A study conducted by Harvard University ['Fact check: Is flying safe?' Available online: https://www.theweek.co.uk/97155/fact-check-is-flying-safe] concluded that the chance of a plane crash is one in 1.2 million, the chance of dying from a plane crash is one in 11 million, but chance of dying in a car accident is one in 5,000. These types of studies are conducted by companies related to aviation quite often. Many economic policies and behaviour of the stock markets are based on such studies. Concept of probability forms the basis for statistical analysis.

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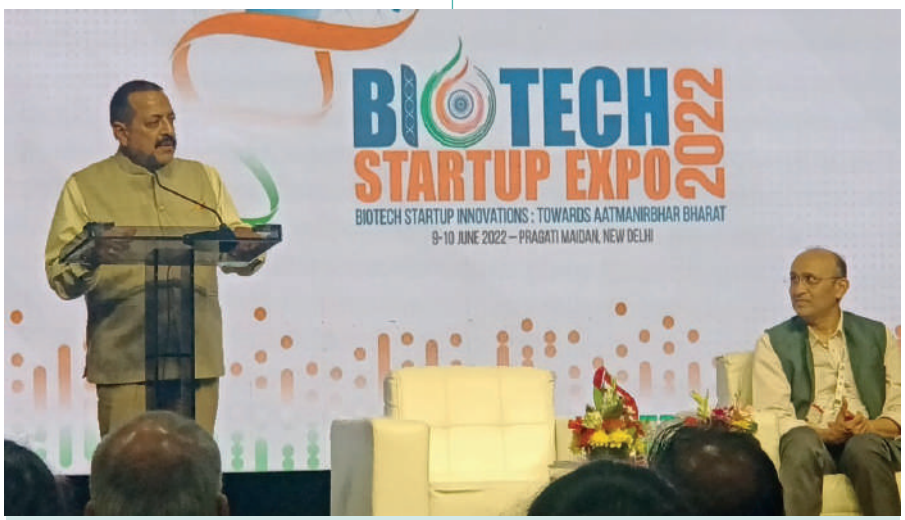
Biotech Start-up Expo 2022

Mansee Upadhyay and Gaurav Jain

The year 2020 has witnessed several record-breaking effects in many ways: be it facing the global pandemic or developing the most significant vaccines in less than a year. COVID-19 pandemic unveiled the importance of biotechnology in many ways. To commemorate successful completion of 10 years of Biotechnology Industry Research Assistance Council (BIRAC), an event was organized on 9-10 June at Pragati Maidan, New Delhi. The theme of the exhibition was "Biotech Start-up Innovation: Towards Self-Reliant India. The event also had a Biotech Start-up expo that showcased 75 successful start-ups and 75 specialized Biotech Incubation Centres supported by BIRAC. The event was graced with the presence of the Hon'ble Prime Minister Shri Narendra Modi. Union Ministers Shri Piyush Goyal, Shri Dharmendra Pradhan and Dr Jitendra Singh were among those present on the occasion. The Hon'ble Prime Minister launched an e-Portal of 750 Biotech Products. At his inaugural speech, he focussed on the role of biotechnology in last 8 years. Over the last few years, the number of biotech start-up has increased from a few to around 70,000. Every 14th start up in the biotechnology sector and more than 1100 such biotech start-up emerged in the last year itself. From 10, biotech products have reached a figure of more than 700 today. While talking about the shift of talent towards the sector, he said that the number of investors in biotech sector has increased by nine times and biotech incubators and funding by them increased by seven times. Addressing the audience he pointed out how the developments in health, agriculture, energy, natural farming, and bio fortified seed are creating new avenues for the biotech sector. Dr Jitendra Singh, Union Minister of State (Ind. Charge) Science & Tech; (Ind. Charge) Earth Sciences; PMO,PP/DoPT, Atomic Energy, Space in his speech pointed the achievements of biotech sector during the last 8 years. It was the biotechnology sector that came as a saviour during COVID-19 pandemic. It came up with the first indigenous DNA vaccine. As of now, trial for a nasal vaccine is also underway. He also pointed out how biotechnology and BIRAC is emerging to motivate the unexplored agricultural and dairy sector start-ups. Dr Rajesh S Gokhale, Secretary, DBT congratulated BIRAC on completing its 10-year journey.

Hon'ble Prime Minister Shri Narendra Modi inaugurates Biotech Startup Expo – 2022

The two-day Biotech Start-up Expo



Dr Jitendra Singh, Union Minister of State (Ind. Charge) Science & Tech; (Ind. Charge) Earth Sciences, addresses a session "The Way Forward" at Biotech Start-up Expo at Pragati Maidan in New Delhi

Hon'ble Prime Minister Shri Narendra Modi. Union Ministers Shri Piyush Goyal, Shri Dharmendra Pradhan and Dr Jitendra Singh were among those present during inauguration ceremony of Biotech Start-up Expo 2022

acted as a platform to connect entrepreneurs, scientist, researchers, bio incubators, manufacturers, and common public and showcase the happenings of the industry. There were start-ups that focussed in the field of healthcare, genomics, biopharma, agriculture, industrial biotechnology, clean energy and waste-to-value products and services. A Delhi-based company came up with a sustainable solution to convert crop stubble waste into useful bio-degradable packaging material with the help of biotechnology. This would minimize the pollution caused by burning of stubble. The product is fire and water resistant and can be degraded in just 60 days in soil. Several start-ups showcased their innovative devices dedicated towards women health like a device for early diagnosis of cervical cancer. A device has been developed for detection and management of epilepsy like medication reminders, medication adherence, seizure diary, etc.

Hon'ble Prime Minister Shri Narendra Modi during Biotech Start-up Expo 2022 at Pragati Maidan in New Delhi

Research findings that can be transferred for mass industrial replication were also showcased in the expo by nearly 75 bio incubation centres. Several

Vegitarian Omelette!

A Madurai-based company has come up with an innovative solution - a vegetarian omelette! It sources plant protein in powder form which can be used in making an omelette. It has higher protein and micro nutrients in comparison to a normal egg can be consumed by vegetarians.

panel discussion were also organised that discussed the future trajectory of bio-economy in the biotech sector. B2B meetings and start-up pitching sessions were also organised where start-ups pitched to a panel and audience comprising industry leaders, MNCs, manufacturers (individuals industry representatives and their associations like AIMED, ABLE, CII, FICCI, FSII, among others). Mature Start-ups out of a pool of 2500+ BIRAC-supported projects interacted with 50-75 investors (including Bio-Angels, BIRAC's AcE fund partners, DPIIT/SIDBI-supported AIFs, other Angels and VC network, HNIs, etc.) and Business/Academic Mentors (TIE group, NASSCOM, Directors, professor, Senior Scientists, Scholars, Subject Matter Experts, Mentors, experts, etc.). During the Plenary Session 'Unicorns' shared the experience that would not only guide but also motivate the start-ups on their onward product development journey. The event also witnessed the book release of Product developed during 75th year of independence and a Coffee book on 75 Women Biotech Entrepreneurs.

Unicorn start-up

Unicorn is a popular term used in the venture capital industry to refer to a privately held start-up company that has reached a valuation of $1 billion.

The emphasis of this event was to inculcate the spirit of 'Sabka Prayas' and to enhance the strategic research and innovation capabilities of Indian Biotech Industry. When independent India will celebrate its 100th anniversary, these start-ups will proudly narrate how they were instrumental in making India Self-Reliant.

Mansee Upadhyay (Project Associate) and Gaurav Jain (Junior Scientific Officer), Vigyan Prasar

Eco brick making activity

Newton Science Club (VP-DL0134), Delhi organised eco-brick making activity for students and stakeholders. The objective of this activity is to aware students about hazardous role of plastic. This activity taught the participants how to make reusable building blocks by packing soft plastic garbage into plastic bottles. Around 60 attendees participated in the activity.

World Blood Donar Day

On World Blood Day14 June 2022 Sharana Science Club (VP-KA0063), Karnataka organised "Know Your Blood Group" camp in the school campus where students and teachers participated. Along with that some basic information on universal blood donor and receiver was shared with the students. Almost 160 students participated in the event. The event was organised at the Kittur Rani Channamma Residential School, Kittur, Karnataka.

World Environment Day Celebration

On the occasion of World Environment Day Darpan Science Club (VP – DL0039), Delhi organised awareness programme for school teachers and students. A tree plantation activity was performed by school students and teachers to spread the message of saving the planet.

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