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In the news

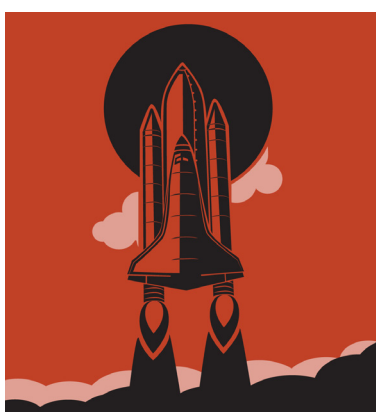
Indian Space Programme

Prof. Mayank Vahia

India's space programme is one of the finest in the world. It is extremely reliable and has been mostly in the service of the immediate needs of the nation. It is one of the finest achievements of modern India.

Recently ISRO made us proud by launching a world record of 104 satellites in a single launch exceeding the previous best of 37 satellites. Such launches are not easy since each satellite has to be launched in its own trajectory otherwise the satellites can collide with each other. Amongst these 104 satellites there were 88 satellites from a single American agency that will allow us to photograph all parts of the earth with a 3.5 meter resolution at least once a day. This will revolutionise our understanding about subtle changes in the earth made by nature and humans

India's space programme began with one of the great visionaries of India, Vikram Sarabhai. Encouraged by Homi Bhabha who initiated India's nuclear programme and supported by India's first Prime Minister Jawaharlal Nehru, Vikram Sarabhai laid the foundation of the programme. Begun originally with the US assistance in sending up sounding rockets that barely went about 100 km up, Sarabhai soon realised the need for complete indigenisation of the programme. Today, India's programme owes no credit to any other nation.



In this highly secretive and competitive human endeavour, Indian programme has made its mark with by far the most reliable launch vehicle called PSLV and as the finest designers of satellites.

Space programme has two components, rocket, the vehicle that takes the object into space and the satellite or the payload that goes into space. Rockets are tricky since they have to accelerate an object from rest to about 11 km/s in a matter of few minutes. Few rocket engines can do it single handed. So typically, the rocket that we see as a rocket, is typically 3 or 4 rockets sitting on top of each other. The lowest most rockets carries the upper rockets to a certain height and then disengages so that the second rocket can be ignited (switched on) to take the payload further into the space and so on, until the payload or payloads that the rocket may carry, are put into their desired orbit.

Similarly, satellites are a distinct challenge of its own. A satellite must withstand being accelerated from 0 km/s to 11 km/s in a matter of few minutes. It must be packed into an extremely small volume – typically a payload bay a couple of meters in diameter and height. Once in space, it must generate its own power through solar panels, and withstand the harsh environment of outer space. Once launched a satellite, in general, cannot be repaired. So it must also be extremely reliable.

Amongst the rockets, India's work horse, the Polar Satellite Launch Vehicle, PSLV can take a payload into an orbit up to 800 km. Originally designed to put payloads into polar orbit (rotating from North pole to South Pole) it has now been modified for a variety of uses. However, the rocket is not very large and can take a maximum of 2000 kg objects into space. India is now in the final stages of testing and approving a far bigger GSLV (Mark 3) which will carry about 5000 kg into space. We will then be able to launch our own communication satellites which we currently launch using foreign rockets.

Payloads may be satellites that revolve around the earth or interplanetary missions. They may be used for observing the earth or observing the space, free from interference of the atmosphere. When the satellites observe the earth, it is preferable that they are kept in an orbit that goes from pole to pole so that as they complete their revolution, the earth, spinning under them, will allow the satellite to see the whole earth with minimal effort. The communications satellites on the earth, should move with the earth so that they complete one rotation per day and are also at the Equator so that they appear stationary to us. These are called geostationary satellites and are used for communication. These satellites need to be at an altitude of about 36,000 km so that their revolution period is 24 hours. Such satellites can be used for communication, weather monitoring etc.

Indian space programme has made India nearly self-reliant in the exploration of space. We not only make and operate our own communication and Earth observing satellites, we also participate in space programmes to explore other worlds. India now also has two kinds of Global positioning systems, namely GAGAN which is used for civilian purposes to help guide aircrafts and ships in their navigation and a system for Navigation with Indian Constellation (NAVIC) also called Indian Regional Navigation Satellite System (IRNSS). GAGAN sits on the American GPS satellites and improves its accuracy from 10 meters to 3 meters using a series of ground stations and three geostationary satellites (GSAT 8, GSAT 10 and GSAT 15)/ NAVIC is entirely indigenous and uses a combination of five of our geostationary satellites (IRNSS 1A to 1G). Out of these IRNSS 1C is geostationary while others are Geosynchronous, that is, they go around the earth once in 24 hours but are at an inclination to the equator giving them a slight vertical motion. Using these it can provide highly accurate positioning system for all Indian needs in civilian and defence arena.

India also has a vibrant space exploration programme. We have sent one mission each to Moon and Mars, flown astronomy payloads on several satellites and now have a completely dedicated astronomy satellite. More missions are in the pipeline.

Our Chandrayan -1 Mission was the first satellite of the Moon to provide unequivocal evidence that there is water on moon – soaked in its soil – like water in a sponge. During its nine months of operation is demonstrated India's ability to use Earth's gravity as an effective sling shot allowing us to send a mission to Moon with much less fuel than other missions. Mangalyaan –

1, a technology demonstration mission established our ability to send a mission that far, again using Earth gravity as a sling shot with great. Reaching Mars is like hitting a ₹ coin 1 km away with a grain of sand moving at 24 km/s. We achieved it in our first try. We are now looking forward to Chandrayan – 2 which will allow us to drive a car on the Moon, an Aditya mission to Sun as well as Mangalyan 2. ISRO is providing excellent opportunity to Indian space explorers to explore the universe.

India also has a unique programme called student sat. These are small payloads, typically 1 meter cubes and 10 watt power which can be designed by students from university with the help of ISRO. These can help students learn the complexity of space programme.

Insights

Biomimicry- Inspiration From Nature

Dr. Uma Ladiwala

If you have walked in the hills when the wild grass is tall, you may have noticed objects from the grasses- burrs- of various shapes and sizes sticking to your clothes, shoes and socks, and which are so hard to detach. If you did manage to remove some, you would have noticed hook-like sharp thorny structures on their surface by which they appear to attach.

Image from Public Domain

In 1941, George de Mestral, a Swiss national, noticed the same and wondered whether he could turn this into something useful. Thus was born the "Velcro" adhesive fastener, comprised of opposing hook and loop fasteners. This ability to imitate models, systems and other elements from Nature by humans, for the purpose of solving problems, is the field of "Biomimicry" or "Biomimetics" *.

Humans have always looked to Nature to find solutions to various problems. Living organisms have developed well-adapted solutions and devices by evolution over time-scales of several billion years. A well-known early example is the study of bird-flight to enable humans to fly. Leonardo da Vinci (1452-1519) studied and made numerous sketches of birds in flight.

Several others later tried to build flying machines, and eventually the Wright brothers did succeed in building an aircraft that could fly in 1903. There are numerous examples of learning and mimicking from Nature by humans. The display screen technology of some current electronic devices is based upon the structure of the wing scales of the Morpho butterfly. This butterfly has vibrant blue wings although there is no blue pigment present in them.

Image courtesy Wikipedia

The colour is entirely due to very fine, microscopic raised ridges and ribs on the scales of the wings that bend, scatter and reflect light in such a way that it appears a vivid blue. Electronic devices use something similar in that the colours seen in pixels are due to the structure of the screen.

Termites are master architects. They build massive, tall structures- mounds- for the colony to live in, especially in Africa as seen below.

Image courtesy Wikiwands

The African daytime heat requires that the mound should have a reasonably cool and constant temperature, and scientists who have studied these noticed that this is achieved by numerous criss-crossing vents inside the mound with convectional air flows cooling the entire structure. This in turn, inspired the design and structure of the Eastgate Centre building in Harare, Zimbabwe that stays cool without any installed air-conditioners.

Some more examples of biomimicry are the making of strong adhesives like that found in mussels which stick to rocks in spite of strong sea currents and crashing waves; reversible adhesives like those found in the feet pads of the common gecko; the water-harvesting surfaces of dung beetles from Namibia that can harvest dew and moisture from fog; the structure of shark skin in swimwear to decrease water resistance. The list is very long. However, we still have much more to learn from Nature, in order to deal with newer challenges and to create a better world for all the Earth's inhabitants.

**Biomimetics: its practice and theory. Julian F.V Vincent, Olga A Bogatyreva, Nikolaj R Bogatyrev, Adrian Bowyer, Anja-Karina Pahl. DOI: 10.1098/rsif.2006.0127*

Science in Daily Life

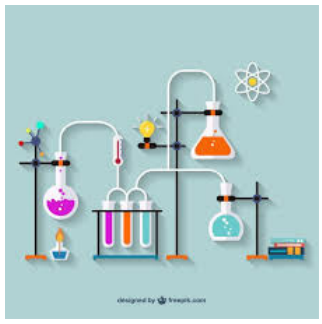
Cook Up a Little Chemistry

Ms. Mona Seervai

If I ask you to think about Chemistry, I can almost guarantee that your mind will start swimming with symbols and equations. Do I hear groans of having to rote memorize all the formulae? I doubt very much that this will cause your mouth to water and enable you to start thinking about all the delicious and healthy food you eat every day. Well, here is a start - knowing a little bit of chemistry can certainly help your mother in the kitchen. Do you really know about all the physical and chemical reactions that go into creating that scrumptious dish on your table? Let's take another look, and consider some of these chemical recipes.

The next time you cook a green vegetable like spinach or broccoli, watch it turn from a dull green to a bright green colour. What is happening here? Did the colour actually change? No, it did not go from one shade of green to another; it is the same green! Let's look at what actually happened: The bright green colour is already present in the cells of the vegetable; it is just that you cannot see the colour clearly, since the green chloroplasts are surrounded by molecules of air which masks the co-

lour. Think of the bright colour being diluted by the colourless air molecules. When the spinach or broccoli is heated, the air in the cells expands, escapes and releases the lovely bright green. Is this a physical or a chemical change?



Why do we ask that the vegetables are not overcooked? Unfortunately, if we leave the vegetables in there too long, we cause the colour to go away. Two things can happen: the cells shrink and the acid in the plant cells may release, and cause the bright green colour to turn into a yucky brown. This is not too appetizing. Sometimes you see this in the rich overcooked food in restaurants. Not very healthy! In order to try and keep the greens green, you can add a little bit of baking soda. Can you see how this helps? The baking soda is alkaline, and this neutralizes the effect of the acid. What sort of change is this?

Think about other ways in which you could preserve the green colour. Just the reverse type of chemical process takes place when you put red cabbage into boiling water. It turns blue! However, if you add vinegar to the boiling water, it retains its red colour. Can you figure out why?

The answer is that red cabbage contains a red anthocyanin pigment, which is acidic in nature. The heat breaks it down causing it to change from an acid to an alkali. The vinegar keeps the pH acidic and hence retains the red colour. Think about what would happen if you added baking soda to the water instead.

Vegetables are good for you, but cakes are more delicious. Think about how the baking soda makes a cake rise in the kitchen. A hint is that the gas escapes making the texture light and delicious! Too much baking soda makes a cake taste bitter. Why? Next time try substituting 'Eno' food salts for the baking soda, to retain the light texture and avoid the bitter taste!

That is all for today. Yummy, the aroma beckons me! So I will sign off and we can return to another aspect of chemistry in the next issue.

Through A Lens

Can You Identify This Bird?

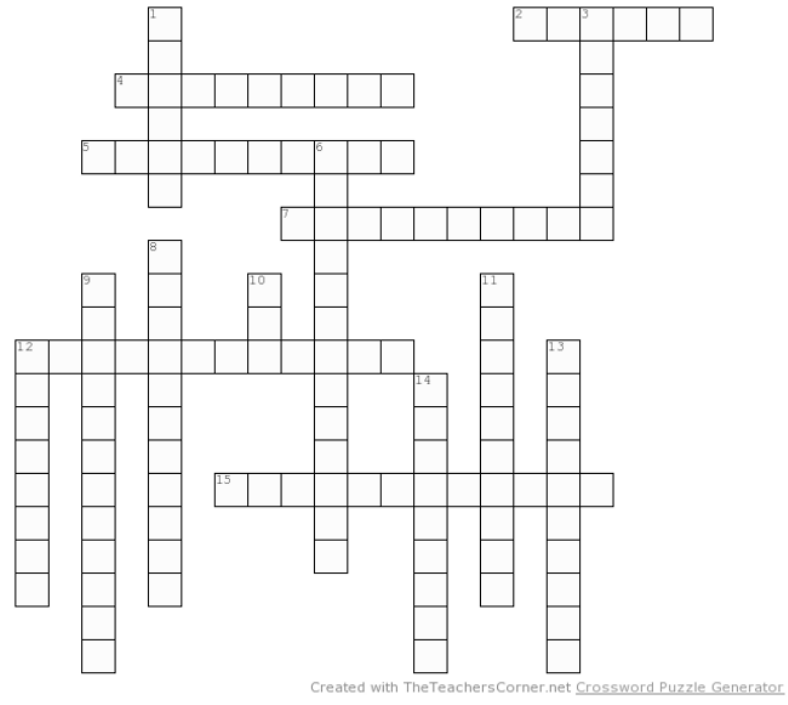
Stimulate Your Grey

Down:

1. Liquid in which peripheral blood cells are suspended
3. Major subtype of lymphocytes
6. Less mature erythrocytes
8. Iron containing pigment in RBC
9. Process by which neutrophils eat up bacteria
10. Complete Blood Count
11. Another name for WBC
12. Cells derived from bone marrow megakaryocytes
13. Blood is a type of this tissue
14. Largest cell in the peripheral blood

Across:

1. Conversion of fibrinogen to this molecule helps form the clot
3. Inactive X chromosome as nuclear appendage in neutrophils
5. Measure of total volume of RBC relative to total volume of whole blood sample
7. Cell from which all blood cells arise
12. Cells that secrete antibodies
15. Another name for RBC



Long Long Ago

A Change of Heart - The Story of Alfred Nobel (1833 – 1896)

Dr. Gail Carneiro

Alfred Nobel was born in Stockholm on October 21st 1833, one of eight children. His father, Immanuel, was a building contractor with a great interest in arms manufacture, rock blasting and designing steam engines. His mother, Andriette was a gifted woman from a wealthy family and was very close to her son Alfred, who always returned to Sweden to celebrate his mother's birthday. Soon after Alfred's birth, his father lost all his money and had to take up a job in an arms manufacturing unit in Russia. His mother started a grocery store in Stockholm to support the family during this period. Later when his father started prospering in Russia, the family joined him. Alfred's parents could now afford to hire private tutors for him. He was trained in languages, literature and the sciences but Alfred's favorite subjects were English literature and poetry, Physics and Chemistry. When Alfred turned eighteen he left Russia to study Chemistry in Paris and then moved to the US. On these travels he learned about nitroglycerine, an explosive which was much stronger than gunpowder but could not be stored safely as it tended to explode suddenly. Alfred returned to work in his father's flourishing arms manu-

facturing unit and along with his father continued his research on nitroglycerine.

Unfortunately business soon dried up due to the end of the Crimean War and the family moved back to Stockholm. Both Alfred and his father continued to be fascinated by the explosive nitroglycerine. After several attempts Alfred was successful in controlling the explosive power of nitroglycerin and he won his first patent. But tragedy struck the family again. A major explosion in the family workshop killed his younger brother Emil. His father suffered a stroke and was crippled and bed-ridden. His mother was distraught at the family's troubles. In addition, the police were after him, his neighbors were on the warpath and he had several lawsuits pending against him. However in spite of everything Alfred persevered and was finally successful. His work led to the discovery of dynamite and he was now hailed as a great scientist because of its use in building railways, canals, tunnels etc. but of course its greatest importance was in manufacture of ammunition for firearms and weaponry. He manufactured thousands of tons of dynamite and exported it all over Europe. It was the end of bad times for Alfred who became a very rich man.

But in 1888 something happened that shook Alfred completely. His brother Ludwig passed away and a journalist mistakenly wrote an obituary for Alfred. Imagine his horror to see the headline - 'The merchant of death is dead' and discover that he was being described as 'dynamite king', a great industrialist who made a fortune from weapons of destruction. The article stated "Dr. Alfred Nobel, who became rich by finding ways to kill more people faster than ever before, died yesterday." Alfred was devastated and determined to change people's opinion of him. He was largely successful because today he is remembered more for instituting the famous 'Nobel' prizes than for the various explosives he discovered.

Unknown to his family and friends, Alfred left the bulk of his fortune as prize money to be awarded for 'discoveries or inventions in the physical sciences and to discoveries or improvements in chemistry'. Alfred passed away in 1896 and his will, signed in 1895, was expectedly contested by his relatives. However the young executors of his will convinced both relatives and authorities that this was indeed Alfred's greatest wish. The Nobel Prize was first awarded in 1901 and continues to be awarded annually in five areas - Chemistry, Physics, Physiology and Medicine, Literature and Peace. It is by far the most prestigious prize in the world and serves as a reminder of Alfred's great contribution to the progress of Science.

Student Speak

Dear Reader,

This is a science newsletter. For you. What is a newsletter? As the name suggests, it is a short writeup, almost like a letter, giving you what is happening in the world of science, the news. As you know from watching various channels on the TV, news can take many forms. It can be just what is happening at that point of time, it can be about what happened some time ago, it can be views or discussions on what is reported. This newsletter carries similar features. To make it a bit more interesting we have added another form of getting information…we have added a quiz for you to solve; a poem for you to enjoy; an interesting photograph for you to think about. And the most important part is a section where news collected by you can be published.

Why have we started this newsletter? All of us, writing for you, enjoy science. It is exciting to know about why and how things happen, such as change in climate, around you. It is fun to know what makes things, such as a bulb work. It is also interesting to know about people who discovered all the simple things we do or use. Who baked the first bread? (Do we really know this??!) We have been having a very good time trying to answer some of these questions. And we hope to share this excitement called `science' with you. We hope you will enjoy reading these two pages we have put together. If you do let us know, it will make us happy. If you don't, again, let us know, we will try to improve what we share. And do send us something that excites you; something you have observed or something that you did!! Your writings will be included in this section called the Student's speak. Of course, since this is the first issue we have written instead of you…but it will be you the next time!

Editors

We look forward to your feedback and suggestions.
Write to us at spectrum.sciencehues@gmail.com