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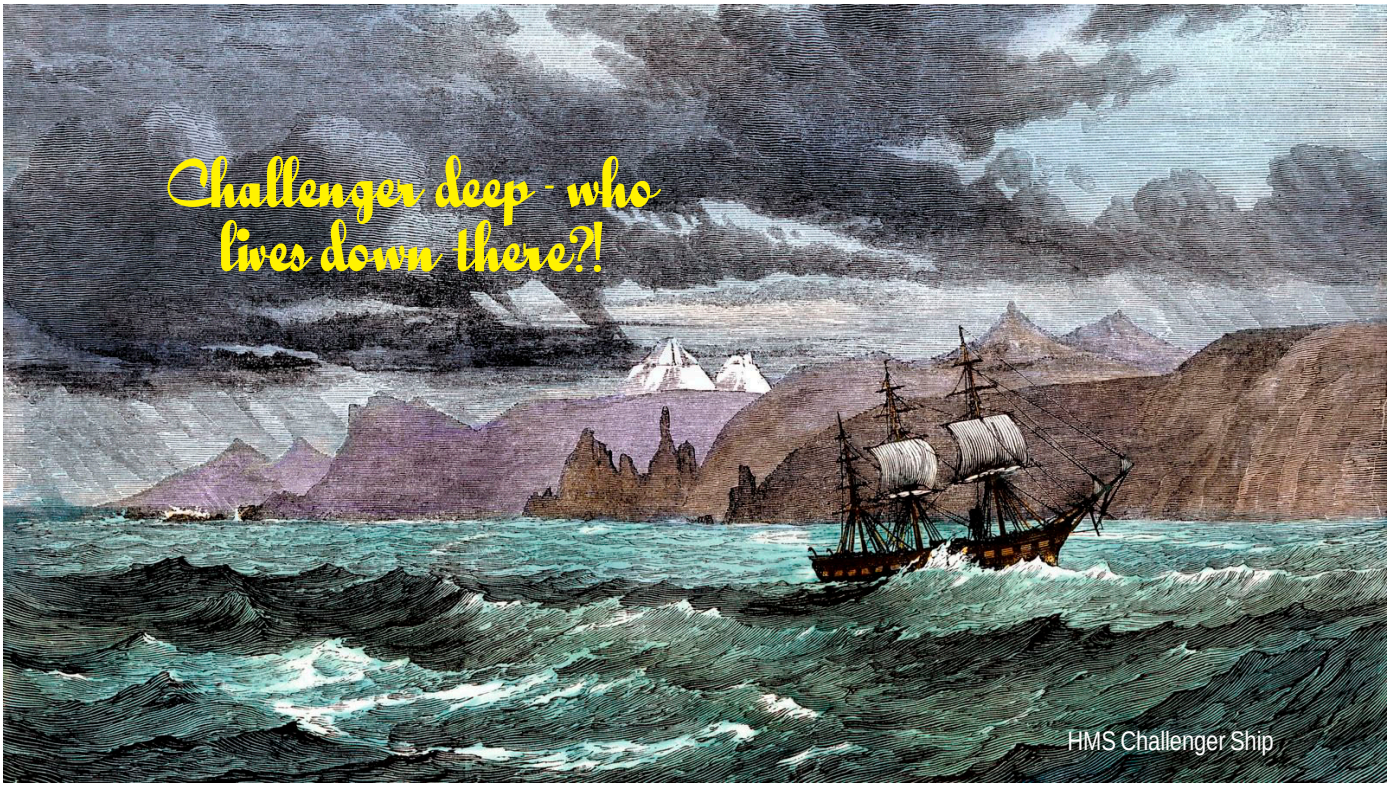
Challenger deep - who lives down there?!



HMS Challenger Ship

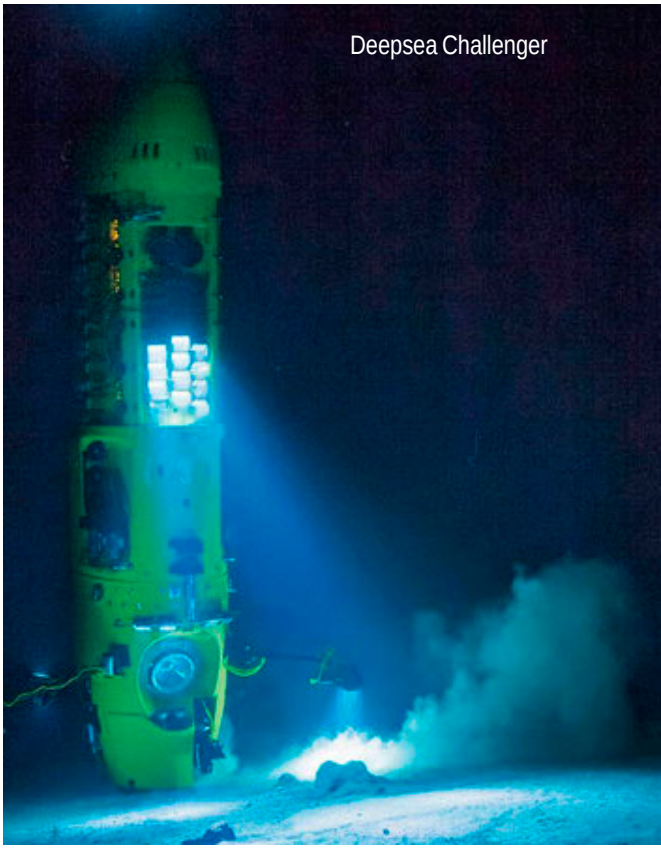
Narayani Subramanian

It is the deepest spot on earth. It is underwater. To put things in perspective, if toss mount everest into it, there will still be 2147 meters left till we reach the surface of the sea!

At a whopping 10,994 meters of depth, the challenger deep is the deepest spot on Mariana Trench in Pacific ocean. Roughly speaking, it is about 11 kilometers deep!

Geological past

Challenger deep is the deepest point of Mariana Trench, found in the western pacific ocean. Trenches are very common features of the deep sea geological system. As we all know, the surface of the earth has a lot of tectonic plates. Trenches are formed in the subduction zone, where two oceanic tectonic plates collide against each other. The mariana trench is formed due to the tension between pacific ocean crust and the philippine crust. Since the



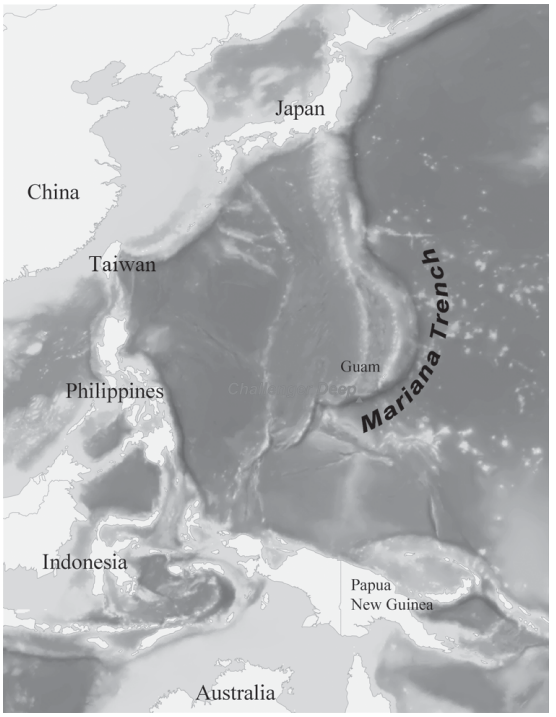
Deepsea Challenger

Descent of Man

The challenger deep was named after the British Royal Navy ship HMS Challenger. It was during one of the expeditions of the Challenger vessel that this spot was discovered in 1876.

Trieste was the first vessel to reach the bottom of the Challenger deep in 1960. Lietenant Don Walsh and swiss scientist Jacques Piccard were present in the submersible. They could not take any pictures, but they gave vivid descriptions of what they saw underwater.

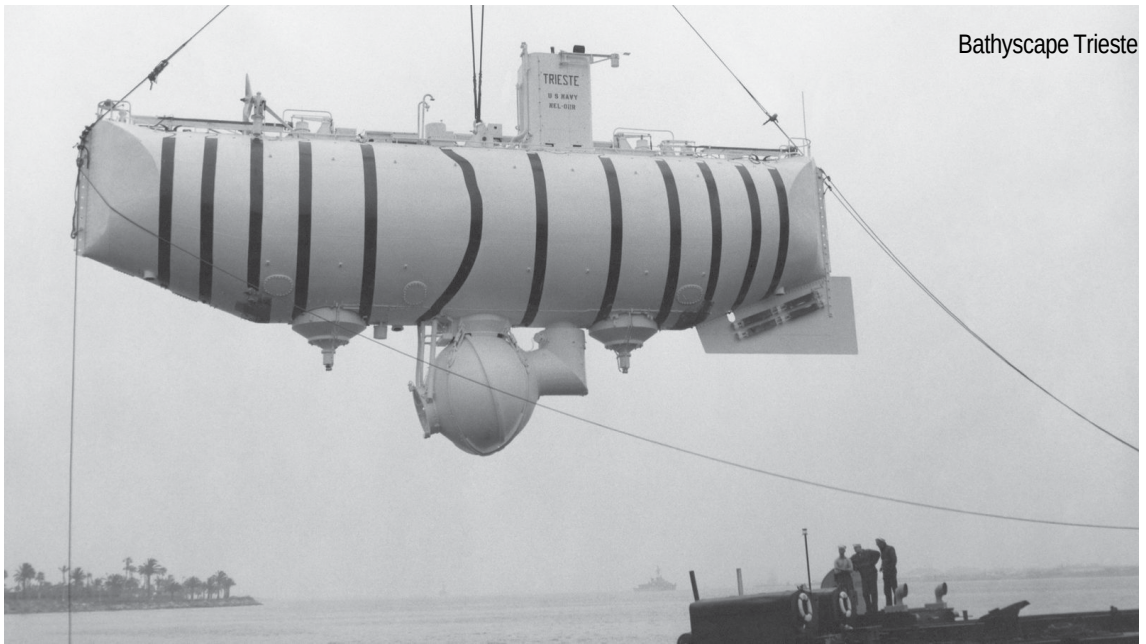
The first man to complete a solo submarine dive to Challenger Deep was James Cameron. Does this name sound familiar? Yes! The director of blockbuster movies like Titanic and Avatar! One and the same! A marine biology enthusiast and curious explorer, James Cameron reached the bottom of the Challenger deep in a deep submersible vehicle in 2012. When he came back to the surface, many pieces of equipment had crumbled under the pressure!



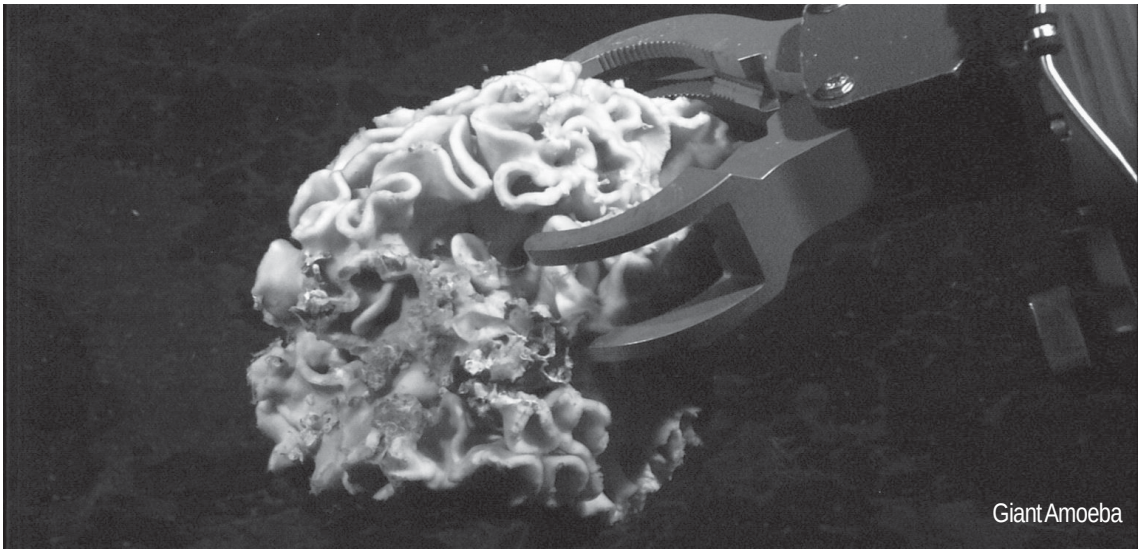
subduction zone is a region of collision, trenches are hotspots of volcanic activity, releasing a lot of minerals into the seawater.

Life in the Challenging depths

Frigidly cold, temperatures here can drop to 1 degree celsius easily. The deep sea is known to have extremely high pressure.



Bathyscape Trieste


Giant Amoeba

The average pressure in Challenger deep is 703 kilograms per square meter, which is the equivalent of 50 jumbo jets piled on top of each other over the head of a single human being! Miles away from sunlight, the challenger deep is known for its pitch black darkness. The absence of sunlight also indicates the absence of photosynthesis, the starting point of food chains. Plants cannot live here, so food is scarce, and the darkness makes it difficult to hunt.

The description of Challenger deep makes it seem like a cold, lifeless place. All scientists once believed the same. Without the life supporting system of sun and the photosynthetic plants, the enormous pressure and the freezing waters of the challenger deep made the scientists think that nothing can possibly survive here.

As always, life finds a way.

Giant amoebas, shrimplike creatures, translucent sea cucumbers and hundreds of microbes live here. They challenge the challenger deep with their survival techniques.

Let us meet them.

1. Giant amoebas

Elsewhere in the ocean, foraminifera (a type of single-cell organism with an external shell) are known for their thick calcium carbonate shells. Here in the challenger deep, the pressure makes it impossible for an animal to have a protective shell covering. So the foraminifera came up with an alternative : soft shells made of proteins, organic polymers and silica material (the main component of glass). They are called Xenophyophorea by the scientists: meaning “Organisms that bear foreign bodies”. They extract the minerals from the surrouding waters and build their soft shells or “tests”. They use their amoeba-like body to grab food particles and nourish themselves. Why are they nicknamed “giant” amoebas? Some xenophyophores can grow upto 20 cm in diameter!

2. Amphipods

Amphipods are shiny cousins of shrimp. Shallow water amphipods are normally

small and microscopic. The amphipods of Challenger deep have made themselves gigantic - some species are a foot long! They have a crystal called scyllo-inositol inside their cells to withstand the pressure.

3. Sea cucumbers

Sea cucumbers belong to the family whose most famous member is the sea star or starfish. The sea cucumbers found in the challenger deep are unusually translucent.

4. Microbes

It does seem that humans are never alone wherever we go. We always have these tiny organisms for company. There are about 200 microorganisms in the Challenger deep, mostly bacteria. Nourishing themselves through a process called chemosynthesis, they utilise the sulphur, carbondioxide, methane and hydrogen released by the tectonic activities. They are probably the most abundant and diverse organisms of the Challenger deep ecosystem.

Life finds a way

Finding out that life can thrive in such hostile environments is a glimmer of hope for scientists searching for organisms elsewhere in the universe. Whenever we search for life in other planets, we keep hear phrases like “Cannot support life”, “Too hot”, “too cold”, “too hostile”. Here on earth, spots like the Challenger deep carry the same descriptions, yet they are teeming with life and adaptability.

May be what humans perceive as a hostile enviroment is welcoming for other life forms.

Looking deep down into the trenches of the ocean gives us hope that life might, after all, thrive high up in space!

Image credits

- James Cameron’s Submersible - National Geographic
- Giant Amoeba - NOAA
- Trieste- US Navy
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- Amphipod - Newcastle University
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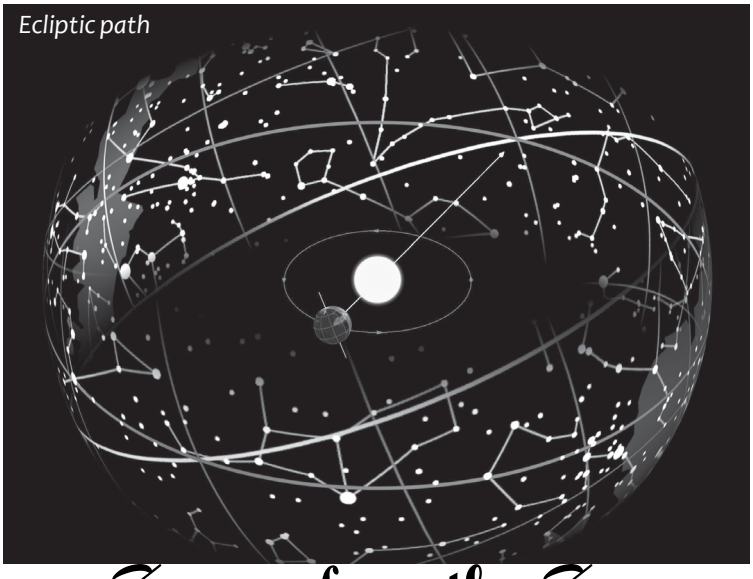


Seasons from the Sun

Kamal Lodaya
Bengaluru

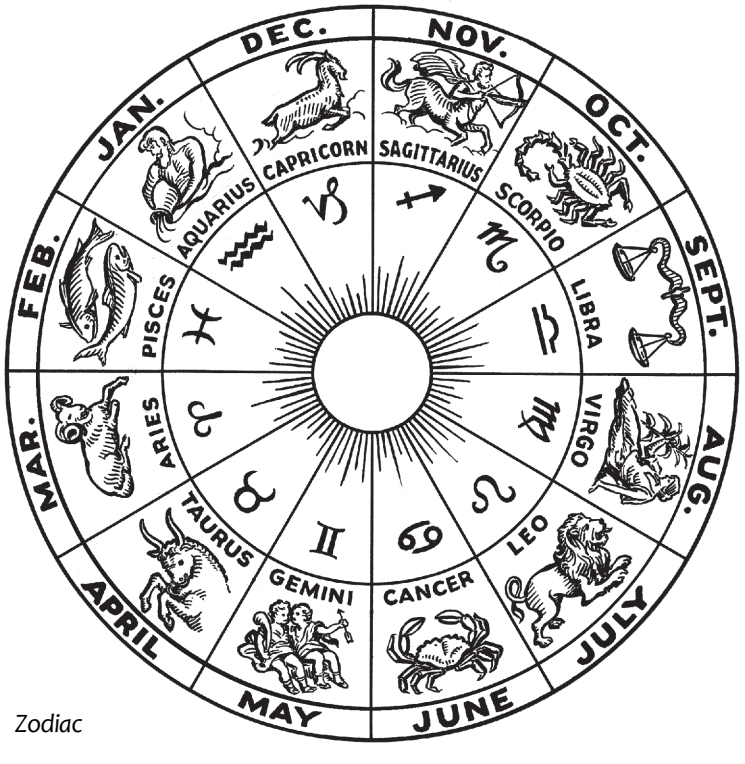
This is a series about calendar makers from history. The last issue's article discussed how the Moon's motion among the stars every day was recorded by 27 *nakshatras*, 12 of these gave names to the months in the year.

Stars at night calculate the Sun in the day

As seen from Earth, the Sun traces a circle around us against the stars in its yearly path in 365.2422 days. This is called a **tropical** or **seasonal** year, for example, from *spring equinox* this year (March 21) to spring equinox next year, when Sun-Earth-stars are in the same positions. Or if you like, from your birthday this year to your birthday the next.

The Sun's path in the sky is divided into 12 *solar rashis* or signs of the Zodiac. These are specific constellations (groups of stars) in the sky. Each has many stars. For example in March and April the stars behind the Sun are from the Meena (Pisces) and Mesha (Aries) rashis.

Since the Sun is so bright the stars in these rashis cannot be seen then. But the Sun and Moon's paths form nearly the same plane, so these rashis overlap with the nakshatras. The 12 rashis have 27 nakshatras,



Zodiac

each rashi has 2 or 3 nakshatras. Which stars lie behind the Sun can be calculated by seeing at midnight the nakshatra *opposite* to the Sun in the sky.

Solar rashis are very old markers for dividing the Sun's path. They were known to the Babylonians of today's Iraq in 1800 BCE. The Babylonians also developed astrological ideas about the supposed effect of stars on humans. Babylonian

Babylonian Star Calendar

Months and Sankrantis

Month name	Rashi of Moon	Purnima date 2021	Sankranti date	Solar rashi	Sign of the zodiac
–	–	–	January 14	Makara	Capricorn
Pausha	Karka	January 28	–	–	–
–	–	–	February 13	Kumbha	Aquarius
Magha	Simha	February 27	–	–	–
–	–	–	March 14	Meena	Pisces
Phalguna	Simha	March 28	–	–	–
–	–	–	April 14	Mesha	Aries
Chaitra	Kanya	April 27	–	–	–
–	–	–	May 14	Vrishabha	Taurus
Vaishakha	Tula	May 26	–	–	–
–	–	–	June 15	Mithuna	Gemini
Jyeshtha	Vrischika	June 24	–	–	–
–	–	–	July 16	Karka	Cancer
Ashadha	Dhanu	July 24	–	–	–
–	–	–	August 17	Simha	Leo
Shravana	Makara	August 22	–	–	–
–	–	–	September 17	Kanya	Virgo
Bhadra	Kumbha-Meena	September 20	–	–	–
–	–	–	October 17	Tula	Libra
Ashwina	Mesha	October 20	–	–	–
–	–	–	November 16	Vrischika	Scorpio
Kartika	Vrishabha	November 19	–	–	–
–	–	–	December 16	Dhanu	Sagittarius
Mrigashira	Mithuna	December 19	–	–	–

In January there is 14 days gap between sankranti and purnima; in December only 3 days.

Vasantotsava and other festivals

The plays *Malavikagnimitram*, attributed to Kalidasa, who is thought to have lived in the 5th century CE, and *Priyadarshika*, attributed to emperor Harshavardhana of Kannauj in the 6th century CE, begin with talk of the same play (that is, *Malavikagnimitram* and *Priyadarshika* themselves) being prepared for the festival of spring, **Vasantotsava** (वसंतोत्सव or வசந்தகால விழா).

Stories of plays by Harshavardhana come from earlier Buddhist sources. The story of Agnimitra is based on a Shunga king from Vidisha (Madhya Pradesh) of the 2nd century BCE. The Shungas came to power after the Mauryas of Pataliputra (Patna). Emperor Ashoka commissioned the great Buddhist ***stupa*** at Sanchi (Madhya Pradesh). Pushyamitra, the first Shunga, began by destroying the ***stupa*** and persecuting Buddhists. The next king Agnimitra rebuilt the stupa.

Drinking and throwing coloured water for Vasantotsava appears in *Ratnavali*, a play from the 7th century CE, attributed to Harshavardhana but more likely by a later author. Holi is on Phalguna purnima. It may have emerged as a combination of earlier harvest festivals with the celebration of spring and of forming new relationships. This year the burning of Holika is on Sunday March 28, and the celebration of colours on Monday March 29.

almanacs are found which list good and bad days of a year, with advice on what to do for every day.

The names of some rashis are very old but they seem to have been finalized in Persia (Iran) in the 5th century BCE. In India the oldest appearance of rashis is in Tamil *Sangam* literature in the 3rd century CE. They are not found in the *Mahabharata* (which has nakshatras), completed around the 4th century CE.

The apparent movement of the Sun from one rashi to another is called a *sankranti*. Since there are 12 divisions in a year of 365 days, sankrantis will happen every 30 or 31 days. March 14 is Meena sankranti and April 14 is Mesha sankranti. Mesha sankranti is the beginning of a new year in many Indian calendars. ●

Months and Festivals

Month name	Purnima/amavasya date 2021	Events
Pausha	January 28	
Magha	February 27	
Phalguna	March 28	Holi
Chaitra	April 27	
Vaishakha	May 26	Buddha purnima/ partial lunar eclipse
Jyeshtha	June 24	
Ashadha	July 24	Guru purnima
Shravana	August 22	Raksha bandhan
Bhadra	September 20	
Ashwina	October 20	
Kartika	November 4	Diwali and Kartika amavasya
Kartika	November 19	Kartika purnima
Mrigashira	December 19	

Festival of the Nile at Cairo, BAP 24819

Seasons from the Sun

Kamal Lodaya
Bengaluru

This is a series about calendar makers from history. The last two articles discussed how the Moon's motion among the stars every day was recorded by 27 *nakshatras*, and the Sun's motion among the stars every month was recorded by 12 *sankrantis*.

The beginning of calendars

The earliest calendar we know of is from 2500 BCE in **Egypt**. One of the most important events of the year for Egyptians was ***Sopdet***, the brightest star in the sky, rising at dawn in August. Because within a few days of this, they knew, floods would arrive in the river Nile.

The flooding of the Nile has been celebrated in Egypt since ancient times. This is because Egyptians knew that this enormous amount of water could be used for irrigation. Even today, Egyptians have an annual holiday for two weeks starting August 15, known as *Wafaa El-Nil*.

For Egypt's farmers, having this forecast at hand was very important. So it is no wonder that the Egyptian calendar focused on the Sun and the time of the night at which the star ***Sopdet*** (we call it *Sirius* or *Vyadha* or *Rudran*) rises. It also used some other stars. We call it a *seasonal calendar*.

Lunar Calendar

We saw that from one full Moon to the next takes 29.53 days. Twelve such lunar months gives 12 months times 29.5 days/ month = 354 days. There is a 11 days gap to match the lunar calendar with the seasonal year, when Sun-Earth-stars come back to the same relative positions. What to do about the extra days every year?

In a desert climate, seasons and

cultivation were less important. Forecasting the phase of the Moon to guide travel at night was more important. In the 7th century CE, prophet Muhammad gave a sermon in Mount Arafat (**Arabia**) giving primacy to the lunar months, ignoring the 11 days gap altogether. This was incorporated in the Islamic calendar, whose months keep shifting by this gap every year. Thus Muslims fast for Ramadan at different times every year. We call it a *lunar calendar*.

The missing days

As early as the 21st century BCE, calendars in Sumeria (**Iraq**), another agricultural civilization, tried to use both the seasons marked by the Sun and the months marked by the Moon. They would follow the lunar calendar. After around three years, when there would be a gap of 33 days, the king would decree that there would be an *intercalary* month (we call it *adhika* or extra month), and there would be 13 months during that year. This would bring the calendar more in line with the seasons.

Leap of day

So you leaped ahead and spotted that this leaves a gap still? Yes, who would keep track of all this? Kings were usually busy fighting other kings and expanding their kingdoms. They had astrologers who would maintain this information. They would advise their kings on when it was time to introduce an extra month.

Could one devise a calendar which would do this by calculation?

●

Egyptian festivals

One bunch of festivals celebrated by the Egyptians in 2500 BCE were called *Wag*, *Wepet-Renpet* and *Tekh*. Their dates depended on the flooding of the Nile in summer, some time in August. They celebrated the death and rebirth of **Osiris**, the Egyptian god of fertility, agriculture, vegetation, death, resurrection and life. Solemn rituals marked Osiris's death: people would make small boats and shrines of paper, which would be floated on the Nile. Then lamentations (poems) were recited to call Osiris to his feast. Feasting, drinking, singing and dancing marked his rebirth.

Islamic festivals

Facing religious persecution, prophet Muhammad moved (this is known as the Hajira) in 622 CE from Makkah (Mecca in English) to Yathrib, which was later renamed Madinah al-Nabi (city of the prophet, or simply Medina). He found that the people there celebrated festivals of merriment. Muhammad instead introduced *Eid al Fitr*, the breaking of the fast after Ramadan. It is the first day of the month of **Shawwal** on which Muslims are forbidden to fast. They have to go to the Eidgah (mosque) and pray, followed by a sermon. *Zakat al fitr*, an act of charity, has to be performed before the prayer. This year the month of Ramadan is from Monday 12 April to the *amavasya* of Tuesday 11 May. *Eid al fitr* will be celebrated this year from the evening of Wednesday 12 May and on Thursday 13 May.

You may think 2021 marks the beginning of the 1400th year since the Hajira. That is not so, because by the Islamic lunar calendar, 1442 lunar years have passed since then. 11 days every year have led to the passing of 42 more lunar years.

Deepavali

Jains trace the tradition of lamps being lit to commemorate the nirvana of their teacher Mahavira. **Buddhist** monks are said to have lit lamps for dark nights of *amavasya*, New Moon.

Hindu puranas have many legends and traditional stories. Those from after the Gupta empire, possibly composed in South India around the 8th century CE, mentioned the festival of lights. So *Deepavali*, celebrated on *Kartik amavasya*, may have emerged as a combination of earlier harvest festivals with emphasis on cleaning houses, lighting lamps and wearing new clothes.

It is one of the most popular Indian festivals, taken by Indian migrants to countries all over the world. This year *Deepavali* or *Diwali* begins on Thursday 4 November.

Did you know of the Madras Hedgehog?

Zareena, Mookayi and Mari

Usha came out of the house talking to someone. She saw her daughter Mari along with her friend Zareena at a distance standing under a tree close to the forest area. They had come for the weekend to Mari's friend Mookayi's grandparents house near a forest area outside of Coimbatore. Mari and Zar seemed to be looking down at something. Just then Mooks came out with her grandfather from behind the house. Usha waved to Mooks and said "What's happening?"

Mooks left her grandfather and came over to where Usha was standing saying: "The three of us were walking near the edge of the forest area when we saw this small thorny creature going towards the forest. So we went near to see what it was. I told Mari to be quiet but she kept talking loudly to Zar. Suddenly the animal curled into a ball and was motionless. We went close and saw it was about the size of a small coconut. Only it was covered with spines and so we did not touch it. I left Mari and Zar standing there to see what happens. I came to check with Thatha what it could be. He says must be a '*mull eli*'. But it is not a rat".

Usha laughed and spoke, walking along with Mooks towards where Mari and Zareena were standing: "Your Thatha is right. I remember reading last week about this '*mull eli*' in an article my friend Vijaysree sent me. She had written about the **Madras Hedgehog** and a person Dr. Brawin Kumar who works passionately for conserving it. It is called '*mull eli*' ('thorny rat') in Tamil because people think it looks like a mouse covered with thorns".

When they reached the spot, they found this small animal still curled up like a ball. They took photos of it with Usha's mobile. Usha said "If we all are standing here, it will not uncurl and walk. It is afraid and so to protect itself it does this. Let us move away and watch from a distance. You will find it again around here, now that you know

where to look".

So they watched from far and surely but slowly, the thorny ball became like an elongated blob with spikes which started moving. Usha had to restrain the three from running towards it to see from close by warning them it will again curl up. Soon the hedgehog disappeared into the shrubs. The three friends started talking animatedly to each other at once.

Usha: "If you are not doing anything now, why don't we go inside and I will show you Vijaysree's article in my laptop. You three can read up more about it and tell us all what you found out later. Maybe in the evening or tomorrow morning you can come to this spot again to see if your friend '*mull eli*' is wandering around.

Mari: "Good idea. We can bring the Mook's binoculars and Zar's camera so we can see and take photos from a distance itself".

Zar: "We could make it our weekend project during our stay here".

Mooks: "Great. I am sure

Interview with Dr Brawin Kumar

Dr Brawin Kumar

Dr Kumar got his PhD from the prestigious Chinese Academy of Sciences in Beijing, China. He is presently an National Post-doctoral fellow at IISER Tirupati, working in the School of Biology. While researching on the habitat and food habits (they like insects) of hedgehogs, Brawin Kumar has put together a fascinating story about their lives.

He says that, being insectivores (insect eating), hedgehogs are a friend of farmers and indeed are often found in cattle-grazing fields. Unfortunately, because of their name (and the association with rats), people do not think twice about killing them. They are also killed because people believe that their skin and spines have medicinal powers.

So he is passionate about conserving the Madras Hedgehog, and is running a rodent conservation project in Yercaud hills, Salem. As a part of his efforts to save this shy and elusive creature, he has recently published a comic book in Tamil for children in Tamil Nadu, who live in and around the hedgehog's habitat.

You can read more about him and his conservation efforts from the excellent interview available on-line at the references listed below, or contact him at brawinkumarwildlife@gmail.com

The **Madras Presidency,** under British rule, included a large part of southern India (see map). After independence, it was subdivided into Andhra Pradesh, and parts of Tamil Nadu, Kerala, Karnataka, Telangana, Odisha and the union territory of Laksha dweep. The city of **Madras** (now called Chennai) was the winter capital of the Presidency and **Ootaca mund** or Ooty, the summer capital. Even Sri Lanka (called Ceylon) was a part of the Madras Presidency for a short time. The map shows the Madras Presidency and the adjacent kingdoms of Mysore, Hyderabad, Cochin, Travancore, and Coorg. So the Madras Presidency was a huge area.

Thatha and Patti will be able to tell us more about this '*mull eli*'. Then we can write it up for our ***Jantar Mantar*** when we go back home. Now that we know what this Madras Hedgehog looks like, we can look for it in Chennai also".

Usha: "Good to hear all your enthusiasm and plans. But Mooks, I must disappoint you. I thought the same when I first read about it in Vijaysree's article. But soon there was another article in The Hindu which cleared my misconception. The Madras Hedgehog also called the *bare bellied hedgehog*. It was discovered in the 1850s in the **Madras Presidency** and so got its name. In fact, it turns out that it was *not* sighted near Chennai (then called Madras) city but more to the north, west and south parts of the Madras Presidency. In any case, I am sure you three as usual will dig up a lot of information".

Thanks and Photo credits: from the interviews with Dr Kumar:

https://www.natureinfocus.in/interviews/quick-five-brawin-kumar

https://www.thehindu.com/sci-tech/energy-and-environment/meet-the-madras-hedgehog/article33942839.ece

Vaccines for Covid-19

R. Ramanujam,
The Institute of Mathematical Sciences, Chennai

2020 was a huge disruption in all our lives. The virus *SARS-CoV-2*, leading to the **Covid-19 pandemic**, has already claimed more than 2 million lives. However, in a great victory for science, vaccines have been discovered for Covid-19 in record time, and already several millions have received shots, including a million health workers in India. Considering that no vaccines have been found for several diseases caused by viruses, and that usually vaccine development normally takes many years, this is a remarkable achievement indeed.

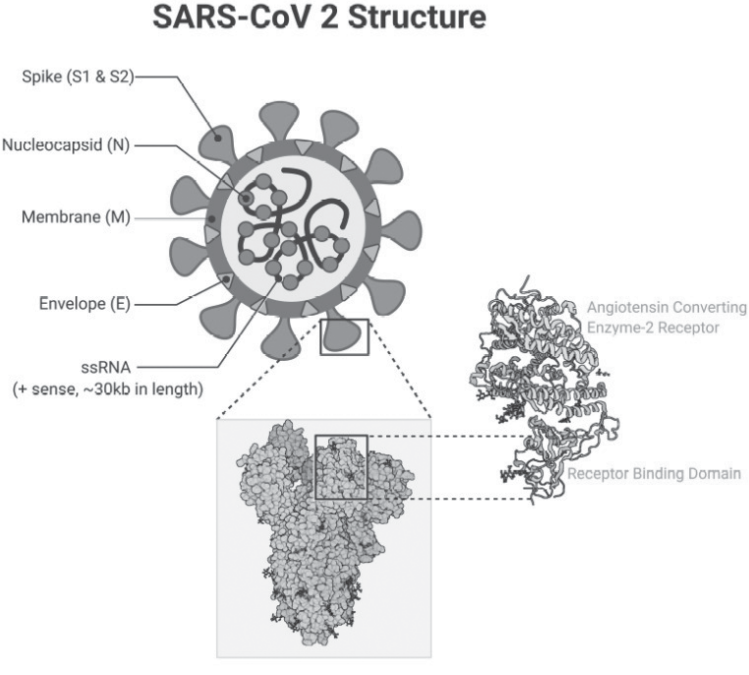
How do vaccines work?

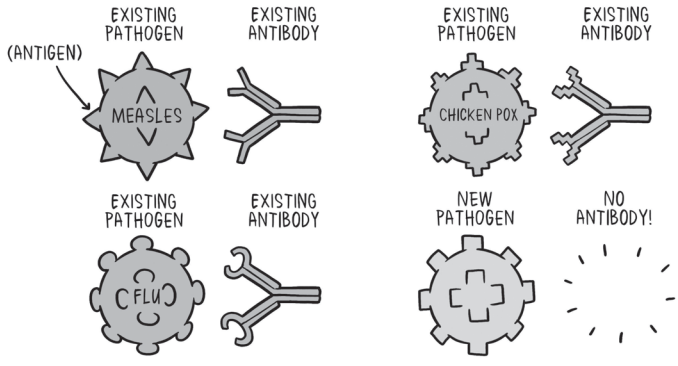
We are almost constantly exposed to many kinds of germs. When we encounter a harmful organism, called **pathogen**, it can cause illness. The human body has many ways of protection against such pathogens. The first line of defence are physical barriers such as skin, mucus and cilia (microscopic hairs) that try and prevent the pathogens from entering. But when they manage to enter, the next line of defence, called the **immune system**, is triggered, which tries to overcome and destroy the pathogen.

Immune Systems

The immune system achieves this by the *innate* and *adaptive* immune system.The *innate* immune system is present in all organisms including **bacteria**. The *adaptive* immune system is present in **vertebrates**. The innate system is so called because it is not dependent on learning from the pathogen. When any foreign organism enters the body, the many different molecules and cells of the innate immune system uses known patterns of molecules to recognise it as foreign and mark it. The *innate* immune system can then destroy it by engulfing (called *phagocytosis*) the foreign cell to break it into parts. This is how we are protected usually from the millions of germs we encounter everyday.

The *adaptive* immune system consists of molecules and cells that can recognise a foreigner and help kill it and in the process also develop a **memory.** So, if the foreigner enters the body again, it can quickly use the molecules and





When a new pathogen or disease enters our body, it introduces a new antigen. For every new antigen, our body needs to build a specific antibody that can grab onto the antigen and defeat the pathogen.

cells of the adaptive immune system to destroy the foreigner (by using the same method of engulfing the foreigner and breaking it up).

The adaptive and innate immune system work together. There are two important types of cells belonging to the adaptive immune system called **T-cells** and **B-cells**. Both the cell types can generate memory cells apart from helping to destroy the foreigner or foreigner containing cell. The B-cells are the ones that produce what we know as *antibody molecules*.

BOXed information without title

A **pathogen** is a bacterium, virus, parasite or fungus that can cause disease within the body. The **antibody** is a response to a part of the pathogen called the **antigen**.

END OF BOX

Each antibody recognizes one specific antigen of the pathogen. At any time, we have thousands of different antibodies in our bodies. When we already have antibodies for a bacterium or virus, we can successfully defend ourselves. Note that antibodies to antigens from one pathogen generally do not protect against another pathogen except when the two pathogens have antigens that are very similar to each other. So, when a new antigen arrives in the scene, it takes time for the immune system to produce antibodies specific to that antigen. In the meantime, the person can become ill.

On the other hand, once the body produces antibodies in response to an antigen, it also creates antibody-producing **memory cells**, which can be restored even after the pathogen is gone. So if that pathogen returns, the immune system responds swiftly and efficiently. The memory cells usually help the adaptive immune system quickly respond if the foreigner enters the body again.

How vaccines work

Vaccines stimulate this process: they contain weakened or inactive parts of an antigen that triggers an immune response within the body. (Recently developed vaccines go one step farther: instead of injecting the antigen, they inject a “blueprint” that produces antigens.) The weakened version thus prompt their immune system to respond without causing illness. This is why vaccines can have a long lasting effect even after the foreigner is not present.

This is, of course, a greatly simplified picture. The amount and type of antibodies produced, and how long lasting they are, matter a great deal. Sometimes a vaccine needs multiple doses, weeks or months apart, to ensure the production of long-lived antibodies and development of memory cells. Good vaccines also help develop T-cell based immunity.

Vaccinating not only protects the person being vaccinated, but also protects those in the

community who are unable to be vaccinated. When a lot of people in a community are vaccinated the pathogen has a hard time circulating because most of the people it encounters are immune. So even those who cannot get vaccinated (because of allergies or other pre-existing illness that weaken their immunity) are also protected. This phenomenon is often called *Herd Immunity*.

One of the world's most successful vaccination programme is that against polio. Its success, especially in India, should attest to the success of vaccination as an important strategy.

Types of vaccines

There are three typical approaches to making a vaccine: using a whole virus, parts of it, or just the genetic material that provides the instructions for making the relevant proteins.

In the *whole virus* approach, there are again three variations: using an **inactivated** vaccine, or a **live attenuated** vaccine or a **viral vector** vaccine. In the first way we inactivate the virus by heat, radiation or chemicals. This works well usually, but making it safe needs a long production time and typically needs more than one dose to be effective. *Polio* vaccines given by injection (IPV) are of this type. In the second approach we use a live but weakened virus. The *measles, mumps and rubella* (MMR) and *oral polio* (OPV) vaccines are of this kind. One disadvantage of this vaccine is that it cannot be given to people who have auto-immune conditions. In the third, only the relevant proteins needed to trigger the antibodies are used, which makes it very safe. This is done by inserting the DNA for making the required proteins into a safe virus, which is then injected. The *Ebola* vaccine works in this manner.

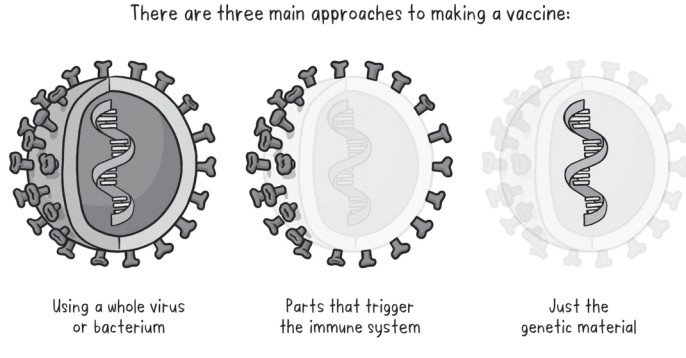
In the *sub-unit approach*, only very specific parts of the vaccine are used which the immune system recognizes. The subunits may be proteins or sugars. Most of the vaccines given to very small children are of this kind.

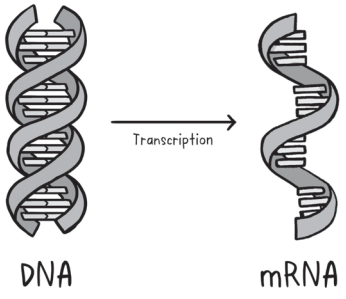
An example of a vaccine that uses genetic material is the *mRNA vaccine* which just uses a section of mRNA that provides the instructions for specific proteins. In our cells, DNA is first turned into messenger RNA (mRNA), which is then used as the blueprint to make specific proteins. Two of the Covid-19 vaccines (called mRNA vaccines) are the first to use this high precision technology.

Vaccine Ingredients

As we saw above, vaccines contain antigens or blueprints for making them. In addition they have other components to make its use safe and effective. These are:

- **Preservatives:** These prevent the vaccine from being contaminated. The most commonly used preservative is 2-phenoxyethanol, often found in baby-care products.





- **Stabilizers:** They prevent chemical reactions from occurring within the vaccine. Typically sugars, amino acids or proteins are used as stabilizers. For mRNA vaccines lipids (fat molecules) are used.
- **Surfactants:** These blend all the ingredients together, and can be found in ice-creams!
- **Residuals:** These are tiny amounts of substances used in manufacturing the vaccine, and may remain though they have no active ingreients.
- **Diluent:** This is to dilute a vaccine to the correct concentration for use, typically sterile water.
- **Adjuvant:** This is to improve the immune response, sometimes by keeping the vaccine at the injection site for a little longer or by stimulating local immune cells.

All these come together in a complex manner to make the vaccine.

Vaccine development

The hardest part is deciding which antigen should be used to invoke an immune response ***and ensuring that it does so without causing illness***. An experimental vaccine candidate is first tested in cells grown outside in plates or bottles (called *cell lines*), then in animals to evaluate its safety and potential to raise immune response. If the vaccine succeeds on an animal, then it is tested in human clinical trials in three phases.

Phase 1: The candidate vaccine is given to a small number of young, healthy adult volunteers to assess its safety, confirm that it generates an immune response, and determine the right dosage.

Phase 2: Now it is given to several hundred volunteers, belonging to the target population, to check safety and ability to generate an immune response. There are usually multiple trials across age groups and different formulations of the vaccine. A "control group" is included, having people who do not get the vaccine, but are given a mock dose (called *placebo*) for comparison.

Phase 3: Now it is given to several thousand volunteers, often across multiple countries, and across multiple sites within the country, to check that the vaccine achieves its purpose on any population.

Usually during Phase 2 and Phase 3 trials, called *random placebo controlled trials*, neither the scientists nor the volunteers know who all received the vaccine and who all got the placebo. Thus they are not influenced in their assessment of safety and efficacy of the vaccine being tried. This is called the *double-blind* approach. In normal times, only after results from one phase are obtained and evaluated, the next phase is started. But in the corona pandemic situation, the regulatory authorities allowed the next phase to be started before completion of the previous phase once preliminary results were obtained. Such parallel processing instead of sequential steps allowed quicker testing of vaccine candidates.

There are usually more reviews of safety and

effectiveness before approval is given. Usually once approval is given by the regulatory authority of the country the vaccine candidates are considered as vaccines and are manufactured and used. During this period also the vaccines are monitored for safety and effectiveness and are called **phase 4** trials. In the corona pandemic situation, the governments allowed the vaccine candidates to be manufactured even before the approvals were made in order to quicken the process.

Covid-19 vaccines in India

Two vaccines are being used in India: **Covishield** and **Covaxin**.

Covishield is designed by Oxford-AstraZeneca (UK) and produced in India by the *Serum Institute* in Pune. It has completed Phase 3 trials in the UK, but not in India. It is made from a weakened version of a common cold virus (known as an *adenovirus*) that usually infects chimpanzees. It is given in two doses, between 4 and 12 weeks apart. It can be safely stored at about 2 degrees C to 8 degrees C (the temperature inside a home refrigerator).

Covaxin is designed and produced by *Bharat Biotech* in Hyderabad, and is entirely an Indian product. Bharat Biotech has a high reputation in the world. Over 24 years, it has produced 16 vaccines and exports to 123 countries. Covaxin is an inactivated virus vaccine. The coronavirus used for inactivation was isolated in National Institute of Virology, Pune. Like Covishield, it needs two doses to be given, four weeks apart. It can be safely stored at about 2 degrees C to 8 degrees C. Phase 1 and Phase 2 trials have been completed for Covaxin, and preliminary results from Phase 3 trials are available, and its safety is assured. Only the effectiveness data is incomplete.

Though the trials are incomplete, the Indian Government approved the use of both on a "restricted, Emergency" basis. The first round of vaccines were administered to front line health workers. Right now, the vaccines cannot be given to children, but is approved for use on the elderly (above 60 years), or persons (above 45 years) with certain existing illness. Once data on trials in these populations become available, these restrictions may be relaxed. Many scientists have questioned this emergency approval, and suggest that we should wait until all clinical trials are complete. But the Covid-19 vaccines protect not only those who take them but also others around them like children and people with pre-existing illness who cannot take the vaccine. So it is a good strategy to administer the vaccine widely.

People who have already got Covid and recovered are also advised to take the vaccine, though they should already have anti-bodies (since they may be insufficient).

The vaccines are not known to have serious side effects. Some people may experience slight swelling, body pain, fever etc. If wheezing or any other serious symptom is seen, that person must be rushed to hospital for emergency treatment.

It is not known how long these vaccines would be effective, but scientists estimate that the protection will last at least six months.

Sources: *https://www.who.int/news-room/feature-stories/ World Health Organization Information on Vaccines;* all images are from WHO. ●

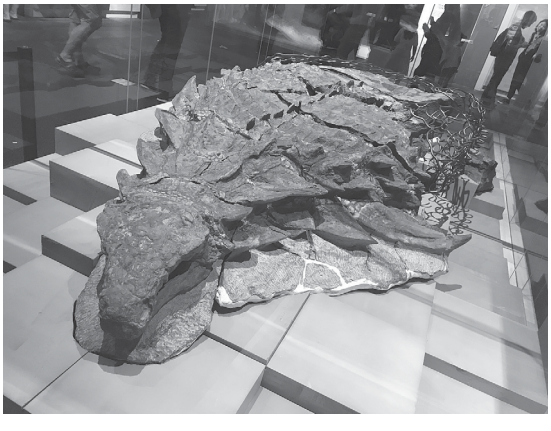
Science Headlines, 2020

A selection of important scientific discoveries of 2020

BIOLOGY

▸ *Dinosaurs*

There were many interesting discoveries on dinosaurs last year. Scientists identified the remains of *tyrannosaurs* so young they had not yet broken free from their shells. Analysis of the remains, which are 71 to 75 million years old, revealed that tyrannosaurs started out surprisingly

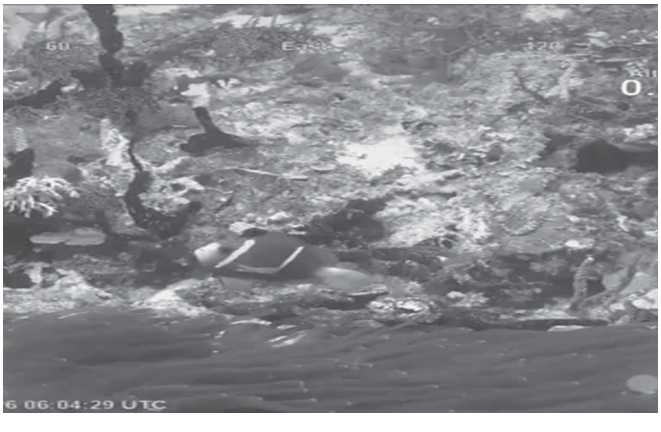


small, measuring an estimated one metre long, but with an extra-long tail.

In another find, scientists got an exceptional look at the final hours of a dinosaur's life more than a hundred million years ago, even what it had for its last meal! It was a *nodosaur*, 110-million-year-old. The ball of fossilized vegetation from its stomach revealed that a few hours before its death, it largely munched on a specific type of fern. The picture shows the nodosaur **Borealopelta** on display at the **Royal Tyrrell Museum** in Alberta, Canada.

When you watched Jurassic Park, you assumed that extracting dinosaur's DNA from fossils was easy. So far, scientists have not managed to do it, but 2020 saw stunning progress: a team identified the outlines of cells, forms that may be chromosomes, and several possible nuclei: the structures that house DNA. They have not been able to extract DNA from the fossil cells, however.

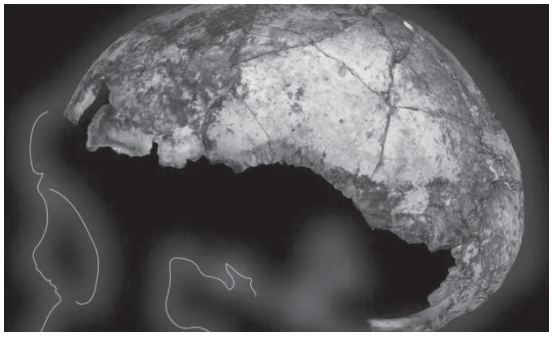
▸ *The Great Barrier Reef*



Scientists mapping the northern Great Barrier Reef seafloor stumbled on a towering skyscraper of coral more than 550 metres tall, nearly as tall as the tallest buildings on earth. A detached reef, it hosts a variety of lifeforms in its ecosystem. It will take some time to analyse all the data coming, but scientists have already found new species of fish. (Pictures from the BBC).

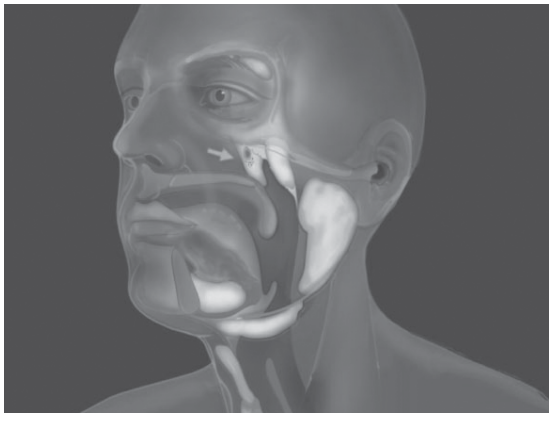
▸ *Homo Erectus find*

Assembling the pieces of a skull found in rocks northwest of Johannesburg, South Africa, scientists were stunned when they realised that



they held the *first* brain-case of *Homo erectus* found so far, dated to some two million years old. The picture shows the Homo erectus cranium outline. It was put together from more than 150 pieces by an Australian-led team in South Africa. (Photograph: Supplied by La Trobe University).

▸ *A new gland discovered*



You would think our doctors know all there is to know about human anatomy. As scientific instruments and tools expand, we keep learning more, and the human body is no exception. Researchers found a new set of salivary glands in the neck that they named the tubarial glands, hidden between the nasal cavity and throat.

▸ *CRISPR*

The 2020 Nobel prize for Chemistry was awarded for development of the CRISPR/Cas9 genetic scissors. Last year, the tool helped in important new therapies: for Leber congenital amaurosis, a rare inherited disease that leads to blindness, for beta-thalassemia and for sickle cell disease.

▸ *Artificial Intelligence (AI) for Biology*

In a very exciting development, AI helped crack a decades-old problem in biology. All proteins start out as a chain of chemical compounds called amino acids. Those chains then fold, twist and turn over and over again into perplexing tangles that eventually develop a three-dimensional shape. This shape determines what the protein can do and cannot, so biologists are keen to know how protein folding takes place. Google's DeepMind has developed a deep-learning tool called AlphaFold that can determine a protein's structure in a matter of days. This can lead to quicker and more advanced drug discovery.

MEDICINE and DISEASE

▸ *Vaccine for Covid-19*

There is no surprise in determining which was the single most important scientific achievement of 2020. It is rare for scientists across the world to work on a single problem of immediate impact on human well-being. This was addressing the challenge of developing a vaccine for Covid-19. There are many virus-caused diseases for which

we do not have vaccines, even after years of research: the *common flu* and the *HIV* being two of them. That pharmaceutical companies developed Covid-19 Vaccines in record time is a great achievement indeed.

▸ *Mitochondria and inflammation*

Scientists found functioning whole mitochondria in circulation in the blood of healthy individuals. Apparently this can lead to a major impact on learning how inflammations are caused, and can be treated.

▸ *Alzheimer's testing*

The first blood test to sample for blood biomarkers indicative of Alzheimer's disease became available for doctors. Apparently nobody expected a breakthrough on this even 5 years ago, but now it is on the market.

▸ *Ebola*

With all the focus on Covid-19, people missed an important success story: on June 25, the World Health Organization declared the end of the second largest Ebola outbreak, which infected more than 3,480 and killed nearly 2,300, most of them in the North Kivu province of the Democratic Republic of the Congo. It also declared the end of the outbreak in Equateur of Congo, in Nov, 2020. Unfortunately, there has been a recent outbreak in Kivu, in Feb 2021. Ebola kills almost half the people it infects, although it cannot be spread through the air, unlike Covid.

▸ *HPV*

In another piece of good news, the world is on track to eliminate a form of cervical cancer associated with the human papillomavirus (HPV) in another 20 to 30 years. This is mainly because pap smears, introduced 50 years ago, help in early screening, and a vaccine introduced in 2006 prevented HPV infection. The combined effect has been very positive.

SPACE

▸ *Bennu Asteroid*

Have you touched an asteroid? For the first time, the **NASA** spacecraft **OSIRIS-Rex** reached out and grabbed rocks from a 4.5-billion-year-old

asteroid named *Bennu*. The mission took place more than 200 million miles away from Earth, and this was a first. The samples collected will arrive on Earth three years from now. Experts think it may contain water and prebiotic material, the building block of life. Such evidence might offer clues about how life started on Earth. The picture shows OSIRIS-Rex readying itself to touch the surface of asteroid Bennu. (Credit: NASA/Goddard/University of Arizona).

▸ *Moon and Planets*

We also learned more about our neighbour, the *Moon*. NASA confirmed water on the sunlit side of the Moon indicating that water may be distributed across the moon's surface, and not limited to the cold and shadowed side.

Farther away, scientists spotted phosphine gas on *Venus*. This opens up the question of whether there is life on Venus.

Data coming from the **InSight Lander** on *Mars* showed a steady hum: a quiet, constant drone that seems to pulse to the beat of "marsquakes" that rattle the planet. This has scientists in a puzzle, as the music of Mars reverberates at a higher pitch than most natural hums on Earth. The sound is truly awesome. If you have access to the internet, please listen to the sound at https://www.nasa.gov/feature/jpl/nasas-insight-hears-peculiar-sounds-on-mars . Watch out for the explanations of the sound you are hearing in the middle of the screen. And now imagine it: you are listening to the sounds from another planet!

▸ *Stars*

Betelgeuse is usually among the brightest stars in the sky, but in December 2019, its intense twinkle mysteriously dimmed. Scientists predicted the death of the star, which will be seen as a Diwali style supernova explosion. But by May the star returned to its normal brightness, belying the doom predictions. Now the explanation is that the star very likely expelled a superhot jet of plasma that cooled as it blasted outward. The process formed a cloud of stardust that could have blocked Betelgeuse's light from viewers on Earth.

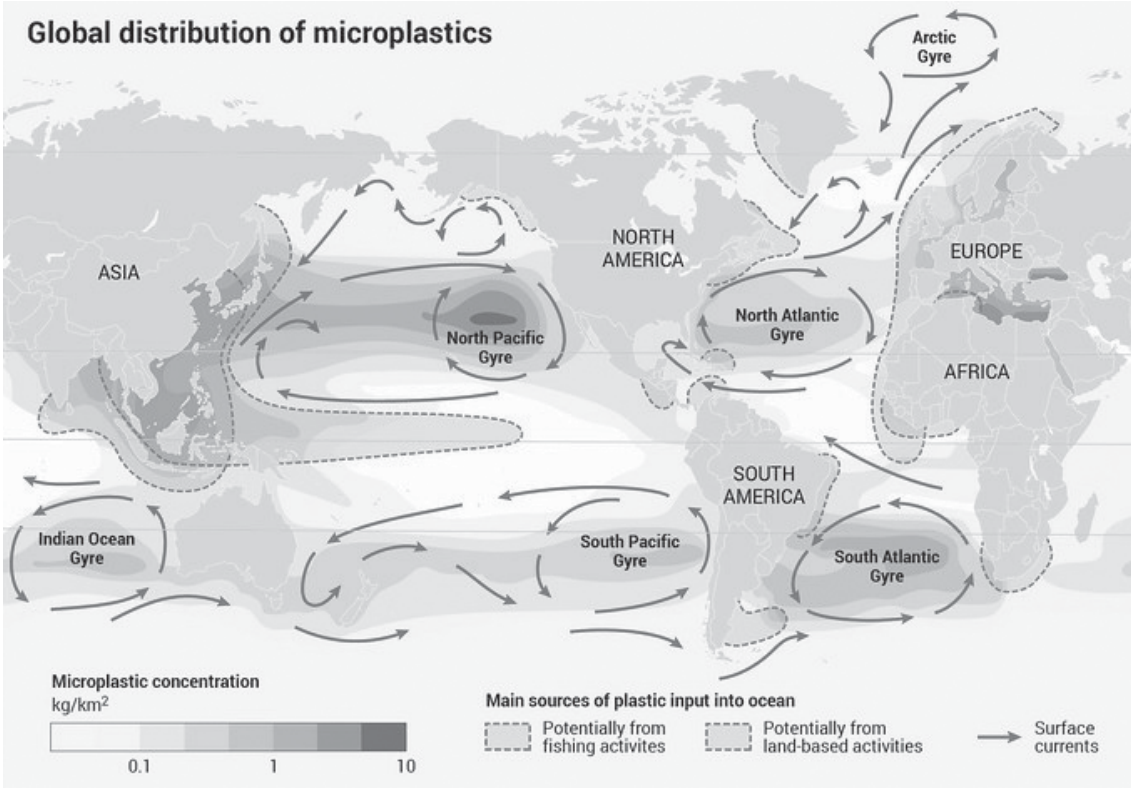
THE EARTH

▸ *Global warming*

2020 turned out to be one of the hottest years ever recorded, just a little behind 2016. This continues a dangerous trend, with the ten hottest years ever documented all occurring since 2005. Millions of acres in Australia burned from October 2019 into January 2020. In Brazil, fires ravaged the Pantanal, the world's largest tropical wetland, from July through October. In the USA, California recorded its worst fire season ever, with more than 3 million acres destroyed. The picture shows wildfires in the Arctic (Credit: Down to Earth).

▸ *Microplastics*

Plastic debris has infiltrated Earth's water, air and the living tissues of many creatures, including humans. Scientists published several studies showing that microplastics have spread both in quantity and in spread in many habitats around



the world. They found microplastics in **Antarctic sea** ice. They estimated that 15.8 million tons of microplastic are embedded in the Earth's seafloor. They found microplastics on the slopes of **Mount Everest**, with one sample at 27,690 feet above sea level.

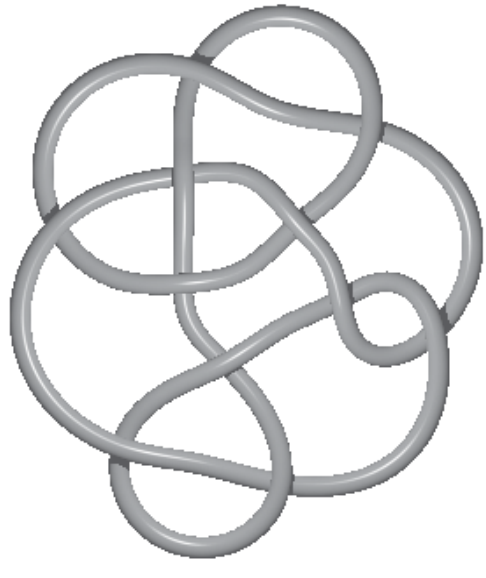
▸ *A world in decline*

A World Wildlife Fund report calculated that in just 50 years, humans have decimated two-thirds of the world's wildlife. Since 1970, 4,392 mammals, amphibians, birds, fish and reptile species' population sizes declined by **68 percent**. Animals living in Latin America and the Caribbean had their population sizes decreased by **94 percent.**

MATHEMATICS

▸ *Knot theory*

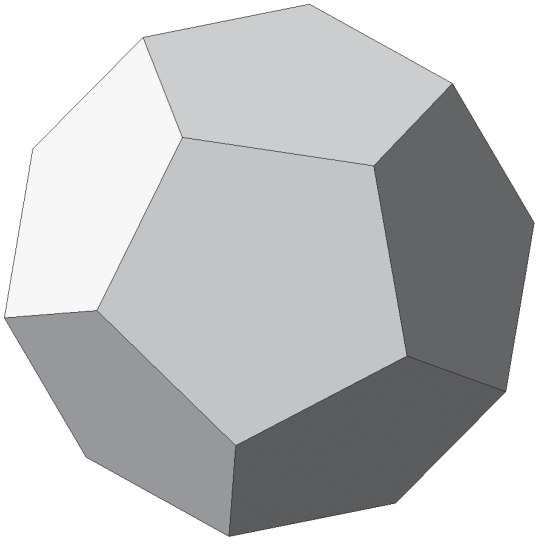
Many consider mathematics to be especially a young person's field. In another demonstration of this, Lisa Piccirillo, a young woman PhD student, solved a decades-old question about knots. She



proved that the Conway knot (see picture) is not a "slice". (Unfortunately, Conway died of Covid-19 without hearing this news.)

▸ *Dodecahedron*

Mathematicians resolved a basic question about the dodecahedron, a 12-sided object (see picture). They showed that it is possible to trace a round trip over the surface of the shape starting at one of the corners without passing through any others. In fact, an infinite number of such paths exist. Mathematicians also solved an old problem about what kind of rectangles can be found by connecting points on a smooth and continuous closed loop. They found that all such loops



contain sets of points that define rectangles of any desired proportion.

▸ *Fermat's last theorem*

When Fermat's last theorem was finally proved, mathematicians found a bridge connecting certain algebraic equations on one side and a kind of symmetric organization of geometric tilings on the other. Called the Langlands correspondence, mathematicians found stunning structures on the bridge last year, vastly expanding what could be found on both sides, revealing deep number theory.

COMPUTER SCIENCE

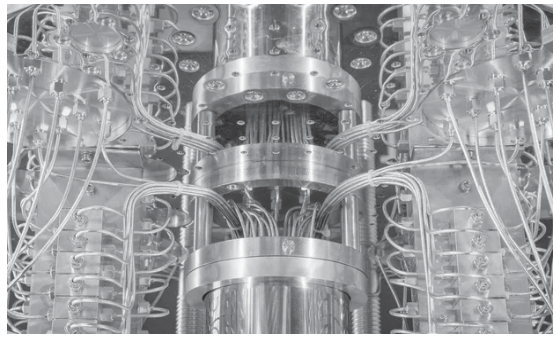
▸ *Quantum Computing*

In a major advancement, scientists showed that quantum computers calculating with "entangled qubits" can theoretically verify the answers to an enormous set of problems. In the process, they solved two major problems, one in physics on models of particle entanglement, and another in pure mathematics, called the Connes embedding conjecture. The picture shows IBM's new quantum computer.

▸ *Travelling salesman problem*

The traveling salesperson problem seeks to find the shortest round trip for any collection of cities. Simple as this sounds, finding an efficient method to solve the problem, or showing that every method would be inefficient, is among the million-dollar challenges. While that challenge remains, scientists used mathematical techniques from what is called geometry of polynomials, to improve the long-standing best method for this problem. Guess how much was the improvement? A difference of "at least" 0.2 billionth of a trillionth of a trillionth of a percent! But scientists are excited by the techniques used, and consider them to be potentially useful for improvements in a variety of other problems.

Sources: The Hindu, National Geographic, The Smithsonian, Quanta



How AI Works (or Doesn't)

Artificial intelligence (AI) has been a hot research area for a long time. Amazon's **Alexa** or Apple's **Siri** are artificial intelligent assistants that help you to use and control many electronic systems. But AI systems still do not seem to have "common sense".

Today, machines can be given words with which to generate an entire article (like this one!). But since they have no experience of the real world (they are not living breathing beings), they may not be able to write sentences that appear natural and sensible.

For instance, here's one example sentence generated by a state-of-the-art model using the words "dog, frisbee, throw, catch": "Two dogs are throwing frisbees at each other."

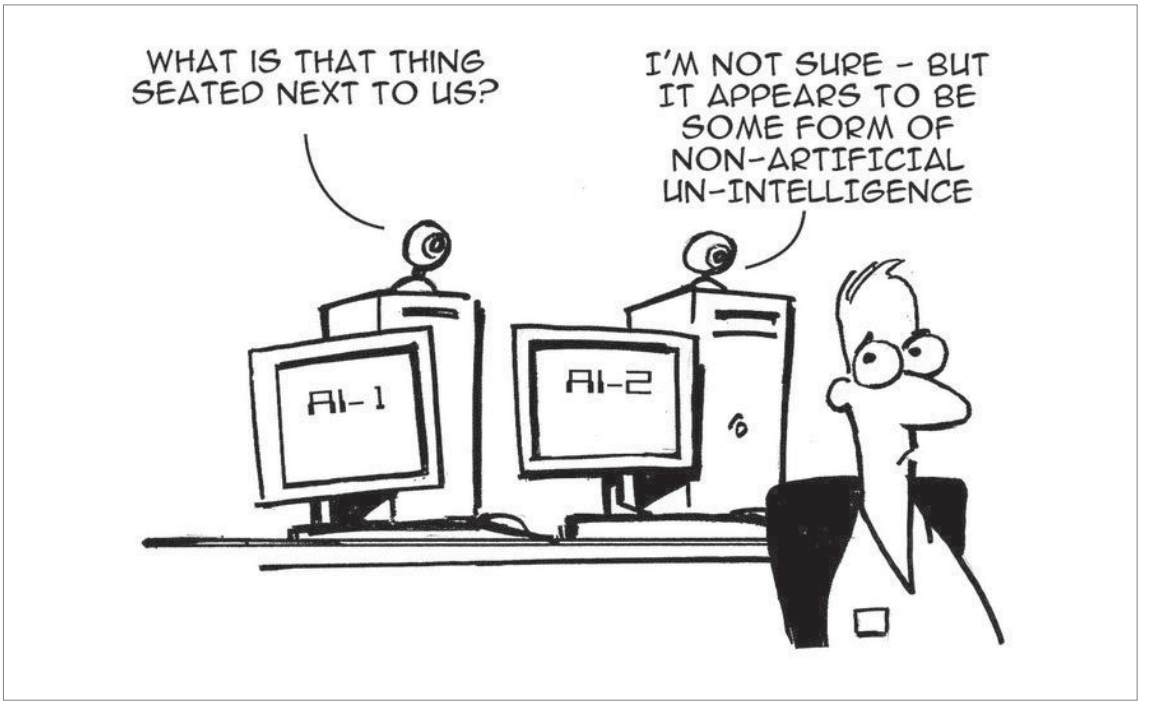
It certainly seems like a reasonable sentence, except that it doesn't make sense! This is a fundamental challenge in the goal of developing AI. Basically there is a lack of experience of the human world, which shows up for instance, when you ask a robot to bring you hot milk: it may not understand that you just want a glass of it and not the entire vessel!

The common sense test

Common-sense reasoning is the hardest to teach. Some claim that modern deep-learning models can now reach around 90% accuracy. But this is hotly contested. For instance, a sentence such as

"I'm afraid that I don't have the money to buy you ice-cream."

is a very simple one. You can immediately understand that the speaker is in some sense apologising for not being able to buy you ice-cream. But think of how this sounds to an artificial intelligence such as a robot. The word "afraid" means to fear something. What is there to be afraid about with ice-cream?!



The sentence

"I don't have the money for ice-cream."

is entirely clear and any robot will be able to understand this. But the first part of the sentence is very hard for a robot to understand since it has no experience of emotions such as regret. Such sentences belong to what is called ***Natural Language Processing*** (NLP) since they naturally occur when we speak.

To evaluate different machine models, **Ren**, and his student **Lin**, who are experts in natural language processing, developed a software called *CommonGen*. This can be used as a benchmark to test the generative common sense of machines. The researchers presented a dataset consisting of 35,141 concepts associated with 77,449 sentences. They found the even best performing model only achieved an accuracy rate of 31.6%. Human did much better at 63.5%.

"Robots need to understand natural scenarios in our daily life before they make reasonable actions to interact with people," said Lin. "By introducing common sense and other domain-specific knowledge to machines, I believe that one day we can see AI agents generate natural responses and interact with our lives." But that day is yet to come. ●

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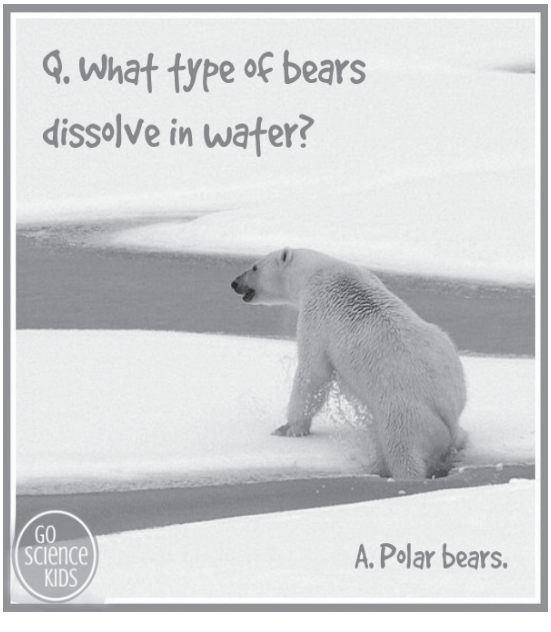

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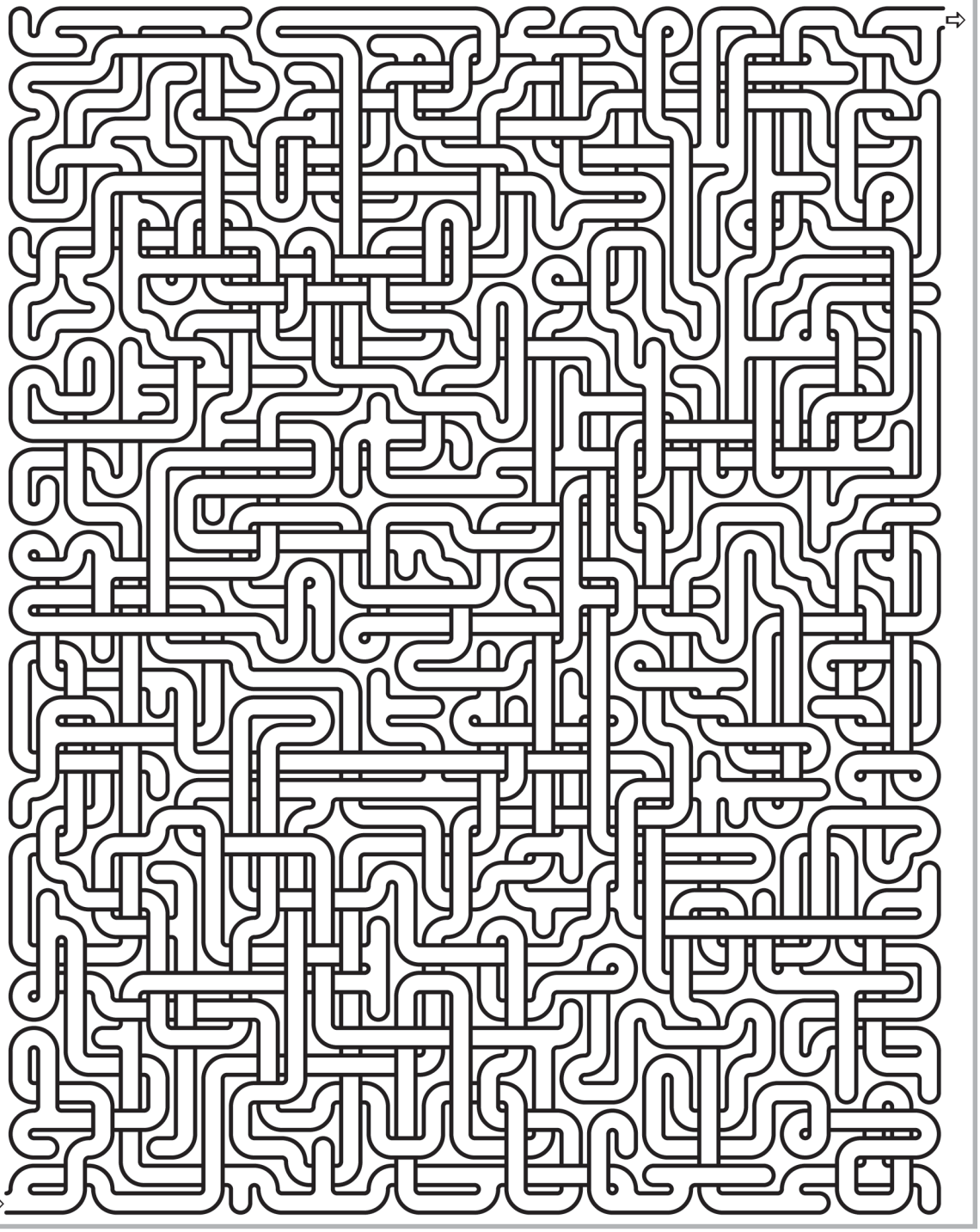
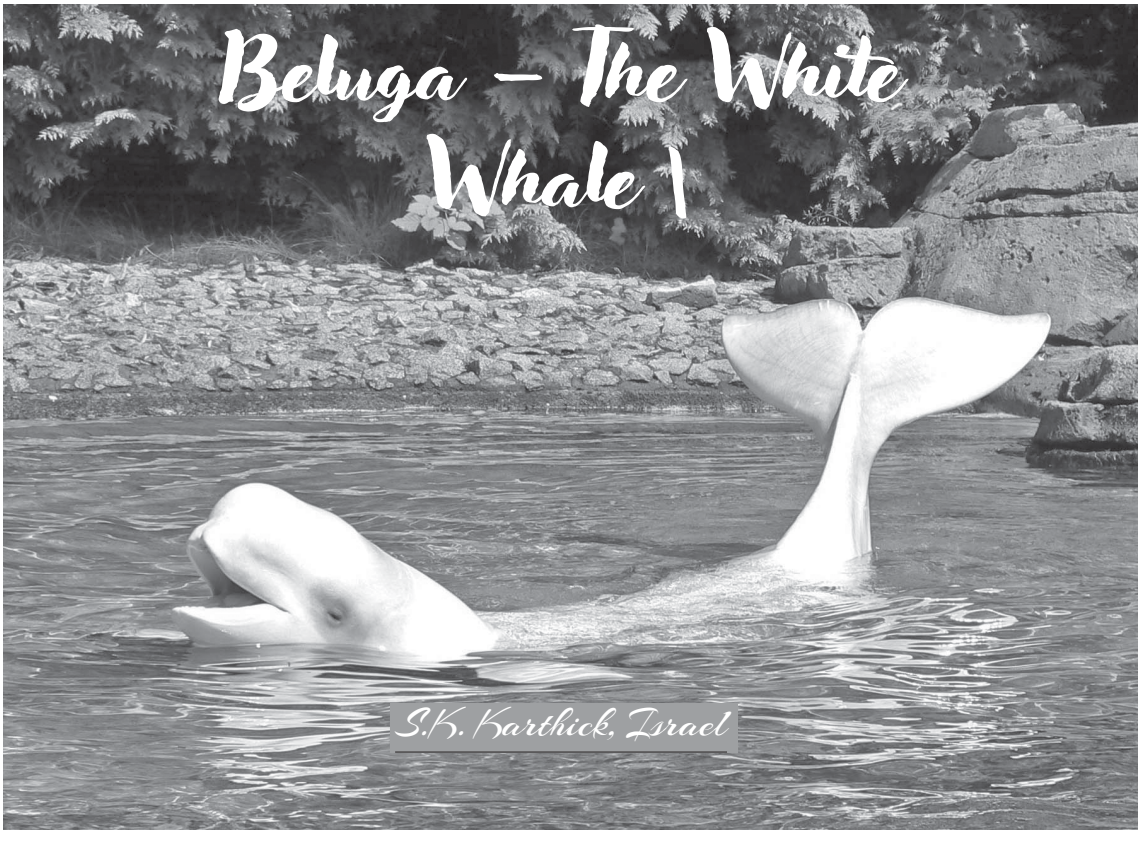


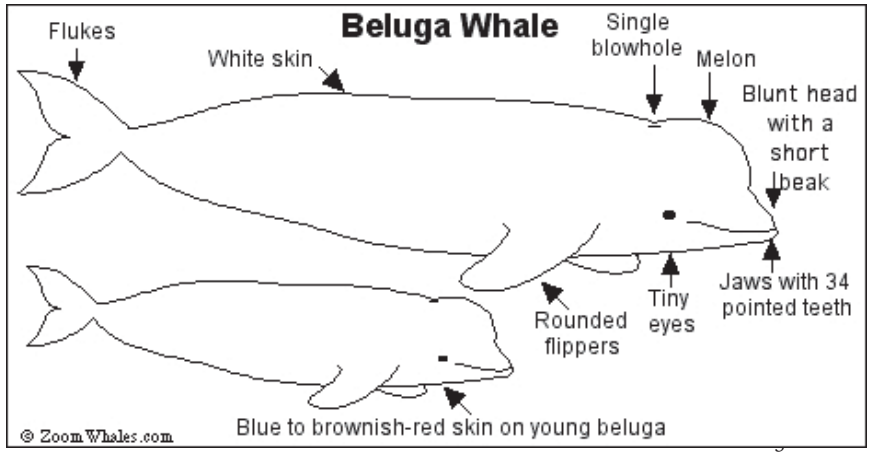
Beluga – The White Whale



S.K. Karthick, Israel

Whenever I am down or free, I immediately skim through the pictures of these beautiful creatures of the ocean called **Belugas** (Delphinapterus leucas). The pictures of them immediately cheer me up. They are the happy chaps of the ocean and have an attitude so similar to our home pets.

Belugas are one of the marine mammals called *white whales*. Like all the toothed whales, they are humongous deep-divers. They breathe through blow-holes and make a huge noise. A matured whale looks completely white and males are significantly bigger than the females. The distinct white color of belugas is acquired as an evolutionary feature.



Belugas lack the traditional *dorsal fin*, like the one sharks have in the back. However, they have the ability to rotate their neck around their body like humans, since their neck vertebrae are not fused together.

Social animals

A male beluga can grow to a length of 5.5 m and weighs 1600 kg. They are extremely social and live in groups. A group of belugas, typically 6 to 100, is called a 'pod.' Unlike other animals, members of a pod are mostly made up of *non-relative* belugas, as identified from recent researches. Pods made of non-family whales make them stronger as the individual members use their collective knowledge about the ecosystem to their benefit.

Belugas are extremely chatty and have earned the name 'the canary of the sea.' They produce many different sounds like chirps, clicks, clangs, whistles, and squeals.

Belugas have a distinct physical feature like a hump on the head which is called 'Melon.' The movement of bones inside the melon produce the necessary sounds for vocalization and echo-location. The bone vibration gets amplified by the squishy melon fluid, and the sound is transmitted through the head. Upon reflecting from the surfaces or sheltering-preys, the signal is received through the lower jaw, and the brain maps a clear vision of the surroundings.

Belugas' vocalizations are unique to a pod or a community of pods in a specific geographical location— just like we have regional languages. They learn the vocalization from their mother and other non-family members during socializing, like a baby learn to babble seeing their elders talking. The communication knowledge and hunting ground locations are passed down to the pod members, as they tend to have a life span of 35-50 years.

Presently, there are over 1,50,000 Belugas in the ocean, and the population is alarmingly unstable.

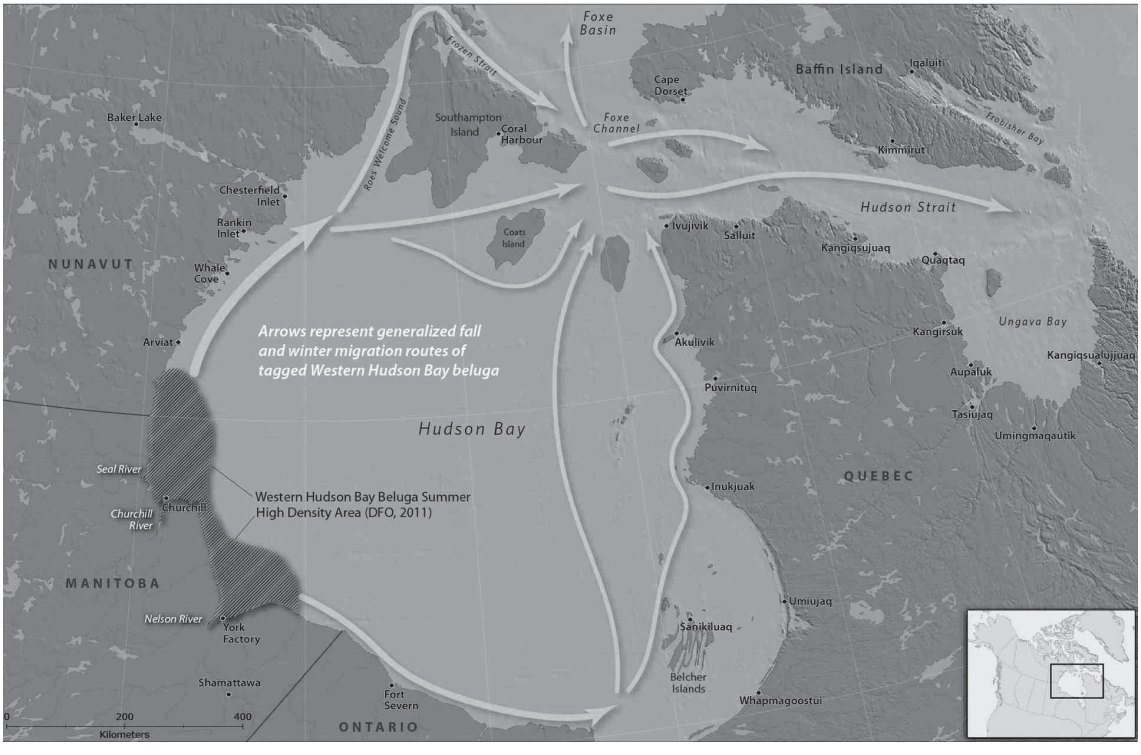
Adaptation to Arctic life

Belugas are warm-blooded animals living in freezing Arctic waters around the north pole. The thick fat deposit (10-15 cm) around the body called 'blubber' helps them to remain warm. It, in fact, constitutes 40% of its body weight. Belugas feed on various sea species like salmons, herrings, arctic cods, crabs, worms, snails, shrimps, and squids. They dive deep to hunt squids and migrate to the estuaries to feed on salmons.

Their white colour helps them camouflage neatly under the arctic ice sheets to avoid predators like the orcas and polar bears. The absence of the dorsal fin also aids while hiding beneath the ice. Both belugas and polar bears are not seen anywhere except in the northern arctic seas.

Migration and spa cleansing

During cold winters, belugas migrate to the lower latitudes having warm waters, especially closer to the estuaries where ocean and river meet. They also swim sometimes into the freshwater as they migrate. Belugas migration event is considered as one of the most



spectacular migrations in the world. Every year almost 2000 belugas migrate to the Cunningham Inlet (Canada) during the summer. Some even migrate to a distance of 6000 km in a year (about half of the Earth's diameter). They swim in large herd in the shallow clear waters. They generally nurse or have calves or socialize during the summer migration.

Belugas perform an interesting ritual at the time of migration. During high-tides, belugas ride the shallow waters where they rub their skin on the sand and mud. They repeatedly splash their bodies against the pebbles and other small rocks. They shed their old skins (moulting) and enjoy having a thorough spa cleansing. In the winter times during foraging (search for food resources in the wild), belugas are covered with saltwater parasites and algae, which turns their white coat to pale-yellow color. Spa cleaning activity is necessary for them to get rid-off the parasites and to reacquire the milky white coat.

Reproduction and Feeding

Belugas are mammals. Beluga gestation lasts for more than 12 months, and it

Belugas and humans

They are a very peaceful species and show no aggression to humans. In fact, a Beluga named Mila saved a diver named Yang Yun. She got paralyzed during a dive into the deep tanks of belugas in Harbin, China. The whale sensed the diver's distress and grabbed her legs. Mila pushed Yun using her nose to the surface quickly, thereby saving her life.

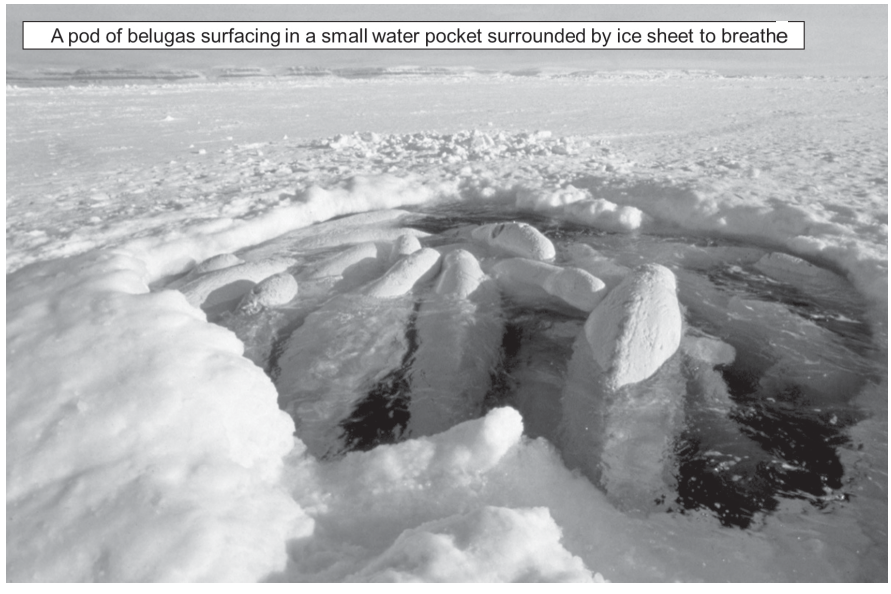
produces a single calf every three years. Elderly females are valued more in a pod as the belugas society is matriarchal. Their knowledge is much needed for the survival of the pod.

A beluga calf is not white in color when it is born. It remains dark grey for almost 5 to 12 years before turning white. Belugas produce huge loads of milk, and the calves suckle for almost 2 years. The milk is fat rich and contains 3000 calories per liter. Family nursing is very common in belugas society. The chances of a calf's survival increase when other female members of the pod babysit for a parent regularly.

Belugas are pack hunters. They travel in a group and encircle their prey. Later they take turns to feed on the trapped fishes. Thanks to their echolocation capabilities, they never go hungry. They also dive very deep, almost to 1000 m in the sea, for hunting prey. Although they have teeth, they only use them to grab the food and swallow it as a whole.

Climate changes, and dumping wastes

Killer whales having a larger dorsal fin cannot sail beneath the ice sheet for a long time to hunt the belugas. They need to surface regularly to breathe.



A pod of belugas surfacing in a small water pocket surrounded by ice sheet to breathe

A covered ice sheet offers hindrance to the killer whales, and hence they leave the belugas in peace. Due to climate changes, arctic ice is melting. When there is no ice, belugas are exposed to the ocean and terrestrial predators. They have no more covers to hide and are killed easily.

A Beluga being transported to a sanctuary

Belugas can hold their breath for only between 15-20 minutes. They need to resurface regularly to breathe. Polar bears spot the small openings in the land surface that belugas use to resurface and dive-in to hunt them. A polar bear weighs about 180 kg but can easily hunt and drag a 1000 kg beluga onto the land surface.

Besides, melting ice releases a variety of parasites which severely affects the beluga population. They go blind, suffer from lung failure, get skin-related diseases and eventually die. Too many chemical dumps seen in the ocean also affect the belugas' health indirectly. Think of tons of ice melting in the arctic and the release of frozen parasites into the water bodies. It will be catastrophic to the entire arctic ecology. Climate change is a real threat to many species!

Illegal displays, and boat hits

Belugas' facial bone structure gives them a smiley face. That does not mean that they are always happy. Entertainment industries like the sea worlds and aquariums capture hundreds of these social creatures for public displays. Most of them are killed during the transport process itself. Many illegally captured belugas are planned to be released into the wild in a progressive way. They are initially moved into a sanctuary where they have a controlled open space to wander and learn to forage. Once they learn to be independent, they will be released into the world.

They also get hit by military vessels and oil containers which regularly move in the Arctic waters. During the early days of the industrial revolution, belugas were killed for their skin (at least by 2000 every year in the 1950s) which were made into belts and bullet-proof vests. Currently, the Canadian government is trying to conserve them.

Noisy ocean floor

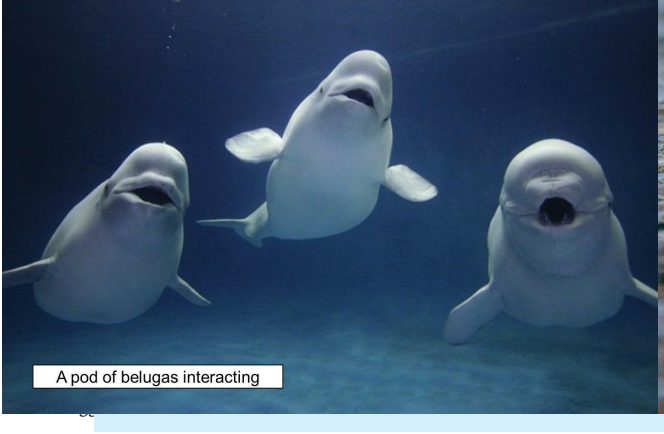
Humans have polluted the ocean floor with a huge noise level in recent days in the name of oil exploration, military navigation, and cargo shipping. The rising temperature in the arctic melts the ice caps, thereby creating further noises from ice crackles and ice ridges. Recent surveys report that the belugas are exposed to almost 85% of the time to an increased noise level around the 10-1000 Hz frequency range (the vocalization frequencies for calling in beluga society) just by ships. These noises travel even to greater depths in the ocean. Whales are extremely stressed due to these noises. They make them disoriented, fail to guide or nurture calves, miss their feeding ground migration, and get more susceptible to other predators.

Sanctuaries

Many researchers, volunteers, and activists are helping to enrich these poor creatures' lives. The Sea Life Trust in the Vestmannaeyjar islands off the south coast of Iceland has opened a beluga sanctuary. Currently, two white whales named Little White and Little Grey are inhabiting the sanctuary. They were transported through an aircraft which traveled for 6000 miles from the Changfeng Ocean World in Shanghai to reach this place in 30 hours. Let's hope the remaining goodness in humans will strive hard to recover the population of Belugas and other whales.


Mother looks white
Calf looks grey
Shallow w


A beluga rubbing its back against the pebbles inside the shallow water


A pod of belugas interacting

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