Children's Science Observatory

# Jantar Mantar

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Tawney Eagle


Finns weaver


Blyths reed warbler


Forest wagtail


Cinnamon bittern


Great indian bustard


Common greenshank


House_sparrow

# How are the BIRDS?

*Zareena, Mookayi and Mari*

Usha was not surprised to see her daughter Mari in animated discussion with her friends Zareena and Mookayi. But they did look and sound like a pandemonium of parrots – colorful and noisy. She had to find out what was going on, especially as when she had left them a few hours earlier, they were each sitting with a book and reading quietly. She went and stood at the door. None of them noticed. They used to read the laptop screen and then break out into conversation all at once.

Suddenly Mari looked up and noticed her mother. Then as if on cue all three saw Usha and shouted, "Amma, the report on **Birds of India** was released. And it is based on *ebird data* which means we have contributed to it. It is so nicely illustrated with birds and data plots."

Usha put down her books and bag and sat down on the sofa. "OK. Tell me."

All three started, "You remember . . ." Usha stopped them. "Talk one at a time. I can't hear you all at once". Mari sat on the armrest of the sofa while the other two pulled up low stools and sat nearby. Mari showed the laptop with the browser opened at the website https://www.stateofindiasbirds.in/ .

She showed the top of the page on which was written, "*This is the first comprehensive assessment of the distribution range, trends in abundance, and conservation status for most of the bird species that regularly occur in India. With their ubiquity and ecological importance, birds are excellent indicators of the state of our natural world and are potent cultural symbols of nature. This national-level assessment of birds is a significant step forward in the monitoring and conservation of India's rich and varied biodiversity . . .*"

Then she scrolled down to the highlights. Usha smiled and said, "Slow down . . . let me read." After a while – which seemed like eternity to Mari, Mooks and Zar – Usha enthusiastically exclaimed, "Oh, this is really nice . . . but where is the ebird mentioned?"

Zar pointed to the methods and data section where it said, "The primary data used in this report is the 10+ million observations uploaded by Indian birdwatchers to eBird (https://ebird.org/india/home ), an online birding notebook. Data on eBird (https://ebird.org/data/download) are freely available for research, education and conservation."

Mooks piped up, "Amma, remember your nephew Ashwin and his partner Bhanu we met in Thattekadu when we went for a



*Front cover: Small Minivet; picture credit https://ebird.org.*


Indian peafowl

birdwatching holiday? Such lovely photos Bhanu used to take of birds...Ashwin amazed us with his ability to identify birds and also had introduced us to this eBird which is available online and as an app. See, this is the app," and she showed her mobile.

Usha looked and asked, "That was almost a year ago. You still have memories of it."

Zar laughed. "Of course, Amma. You think we would have forgotten. Since then we have been putting our bird sightings into the eBird lists regularly. So that is why we are also part of this report".

Mari said, "See here. It says the report uses over 10 million observations uploaded to the eBird platform by more than 15,500 birdwatchers from over 2,00,000 distinct locations in all States and Union Territories and covering over 95% of districts in India."

Mooks chimed in, "Yes, they have used the data to evaluate the distribution range size of 867 Indian birds, and their trends in abundance in both the long term and current."

Zar explained, "They divided the whole country into grids and took the data from us citizen scientists in each grid to make the calculations".

Usha was puzzled. "What is long term and current?"

Mooks clarified, "Long term is using


Lesser goldenbacked woodpecker

data of more than 25 years and current is over the past 5 years. They used the bird identification, frequency of sightings and the locations given by the birders like us in the ebird lists."

Usha read aloud from the site. "Using the measures developed for the analysis, plus information from the International Union for Conservation of Nature Red List of global threat status, this report places Indian species into Low, Moderate and High categories of Conservation Concern for India."

She continued, "They have put 101 bird

species under High Conservation Concern and also say 52% of species show clear decline over the past decade! That is significant. So this is what you were animatedly talking about?"

Mooks exclaimed, "Amma, this is the first report using data from us citizen scientists and professional biologists and ecologists. It is a collaboration by so many organisations. See the list here. . . Ashoka Trust for Research in Ecology and the Environment (ATREE), Bombay Natural History Society (BNHS), Foundation for Ecological Security (FES), National Biodiversity Authority (NBA), National Centre for Biological Sciences (NCBS), Nature Conservation Foundation (NCF), Sálim Ali Centre for Ornithology and Natural


Oriental skylark

History (SACON), Wetlands International South Asia (WI-SA), Wildlife Institute of India (WII) and World Wide Fund for Nature India (WWF-India) ... and Ashwin is part of the team at NCBS. They have also given photo credits to Bhanu for some of her bird pictures."

Zar continued, "The data and the analysis are in public domain. It is freely available and we can also go through, analyse and give our inputs. Amma, you can also get involved even if you did not use eBird till now."

Mari excitedly said, "They find that house sparrows have reduced only in some metros but overall they are roughly stable across the country."

Mooks happily added, "That puts to rest the claims without data that mobile towers and use of cell phones has led to a fall in sparrow population!"

Zar with all her smile put in, "Yes, along with the sparrow, about 126 bird species have stable or increasing trends over the last 25 years. The peacock or the Indian peafowl as they refer to is increasing in numbers and doing well thanks to it being protected."

Mooks making a sad face added, "Amongst the birds that have declined are White-rumped Vulture, Richard's Pipit, Indian Vulture, Large-billed Leaf Warbler,


White rumped vulture


Pacific Golden Plover, Curlew Sandpiper . . ."

Mari went on, "Raptors, migratory shore birds and those birds endemic to the Western Ghats have declined considerably. Maybe that is why we also d id not see many of them during our trip. It seems common species like Small Minivet, Common Greenshank and Oriental Skylark have also gone down."


Zar pointed out the report shows that birds that eat *invertebrates* have declined as a group.

Usha told them look at the bright side. "Now based on the data-driven-report they have made recommendations to the Government, researchers and public for the future to safe-guard and nurture the bird population, for as we know birds are good ind icators of the state of our environment and well being."

Mari not to be outdone said, "Not only that. This also shows the strength of citizen science efforts and openness in making data and analysis methods freely accessible. There are many citizen science efforts related to birds like Bird Count Ind ia, Kerala Bird Atlas, Pongal Bird Count etc., with which we can get involved."

Mooks had the last word however saying, "Amma, hope you will also join us for bird watching more often and become an eBirder scientist so we can help fill up the locations that have not been covered so far. You take such nice photos with your camera. This way we will get to travel also! Can we take a year break from our routine and go on bird watching trips?"

# Highlights of the SOIB Report

Both the Indian sparrow and peafowl have stable and even positive increase over the years.

About 101 species of birds have been categorised as of High Conservation Concern. These threatened and endangered species include the following.

- Raptors such as the tawny eagle and scavengers such as vultures have shown large decrease in populations.

- Water birds have also shown declining populations with migratory shore birds showing the largest declines. Resident waterbirds such as swamp hens have shown particularly severe declines in the past five years.

- Carnivores such as vultures, eagles, hawks and falcons have shown declines, especially since the last 20 years.

- Forest birds have shown the greatest declines of all habitats, such as wetlands, grassland, scrub, but in general all bird populations across all habitats show declines. The great Indian bustard lives in the grassland and is critically endangered, with a loss of roughly 90% of the species over the last fifty years.

- Migratory birds have shown much larger declines than resident bird populations. The steep decline of long-distance migrants is driven by species like Forest Wagtail, Pacific Golden Plover and Common Greenshank.

- Birds which come to India in winter have shown varied responses. While the number of rosy starlings has significantly increased, sightings of Blyth's Reed Warbler have stayed stable over the last 10 years.

- Birds endemic to (native to) the Western Ghats are less in number, with even common species such as Crimson-backed Sunbird and Yellow-browed Bulbul showing declines.

- Finally, focus is newly shifting to smaller birds such as Green Munia, Swamp grass Babbler, Chestnut-backed laughing thrush, Indian Olive Bulbul, Finn's weaver, etc., which are threatened because they are hunted or are suffering habitat loss. Now, with citizen science, even these small and so-far neglected species can be carefully studied.

***Acknowledgements: All pictures from https://ebird.org***

# Nested-radicals

MV Murthy

In Algebra a radical is an expression containing square-root or cube-root. A *nested radical* contains a radical expression inside another radical expression. For example the following expression is a nested radical:

$$x = \sqrt{1 + x\sqrt{1+y}}\,.$$

If it continues without an end, it is called an *infinite nested radical*. These infinite radicals are quite fascinating. For example, a simple integer like 2 may be written as an infinite nested radical:

$$2 = \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{2 + \cdots}}}},$$

where the $\cdots$ indicate that the nested expression continues for ever without an end. Therefore if we stop after four or five square roots, we get an approximation for 2. (Try it and see.) The approximation improves as we include more and more square-root nests but never equals the exact value until the infinite nests are summed (in principle, of course, you really can't sum them in practice). This is a simple example but of course you can have slightly more complicated infinite nested radicals.

**Ramanujan's nested radical problem**

The famous mathematician **Srinivasa Ramanujan** posed one such problem more than hundred years ago. He wanted to know the value of this beautiful nested expression:

$$? = \sqrt{1 + 2\sqrt{1 + 3\sqrt{1 + 4\sqrt{1 + 5\sqrt{1 + 6\sqrt{1 + \cdots}}}}}}\,.$$

In fact the answer is very simple, it is simply equal to 3. Why is that? Let us start with the answer. We have,

$$3 = \sqrt{9} = \sqrt{1+8}\,.$$

Writing 8 as, $8 = 2 \times 4$, and further using $4 = \sqrt{16}$, we can write 8 as, $8 = 2\sqrt{16}$. Substituting in the above equation, we have,

$$3 = \sqrt{1 + 2\sqrt{16}}\,.$$

You may already have noticed that you can keep repeating this trick: write $16 = 1 + 15 = 1 + (3 \times 5) = 1 + (3 \times \sqrt{25})$, etc., to get, sequentially,

$$\begin{aligned} 3 &= \sqrt{1 + 2\sqrt{1 + 3\sqrt{25}}}\,, \\ 3 &= \sqrt{1 + 2\sqrt{1 + 3\sqrt{1 + 4\sqrt{36}}}}\,, \\ 3 &= \sqrt{1 + 2\sqrt{1 + 3\sqrt{1 + 4\sqrt{1 + 5\sqrt{1 + 6\sqrt{1 + \cdots}}}}}}\,, \end{aligned}$$

and so we have the proof!

**Infinite nested radicals for larger integers?**

Now we have infinite nested square-root expression for 2,3. Obviously we may ask the next question, what about expressions for 4,5,..., or in general any positive integer $n$? To find the answer, we just need to follow in the foot-steps of Ramanujan's proof for 3. Let us do this now—just square the Ramanujan expression for 3. We have,

$$9 = 1 + 2\sqrt{1 + 3\sqrt{1 + 4\sqrt{1 + 5\sqrt{1 + 6\sqrt{1 + \cdots}}}}}\,.$$

Take the first number, 1, to the left hand side to get $(9 - 1) = 8$ and then divide the entire equation by 2. We have,

$$4 = \sqrt{1 + 3\sqrt{1 + 4\sqrt{1 + 5\sqrt{1 + 6\sqrt{1 + 7\sqrt{1 + \cdots}}}}}}\,.$$

There you have it for 4. Now things become simple, square the expression for 4 and we get,

$$16 = 1 + 3\sqrt{1 + 4\sqrt{1 + 5\sqrt{1 + 6\sqrt{1 + 7\sqrt{1 + \cdots}}}}}\,.$$

Simplifying again in the same way by taking 1 to the left hand side and dividing by 3 this time, we have,

$$5 = \sqrt{1+4\sqrt{1+5\sqrt{1+6\sqrt{1+7\sqrt{1+8\sqrt{1+\cdots}}}}}},$$

and we may continue endlessly for all positive integers so that the general expression for $n \geq 3$ is given by

$$n = \sqrt{1+(n-1)\sqrt{1+n\sqrt{1+(n+1)\sqrt{1+(n+2)\sqrt{1+(n+3)\sqrt{1+\cdots}}}}}}.$$

**The golden nested radical**

Here is another infinite nested square-root that looks nice and simple but the answer is in fact a famous number:

$$a = \sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\cdots}}}}}},$$

which involves only the number 1. To find the value of $a$, we use the same trick. Just square the expression to get,

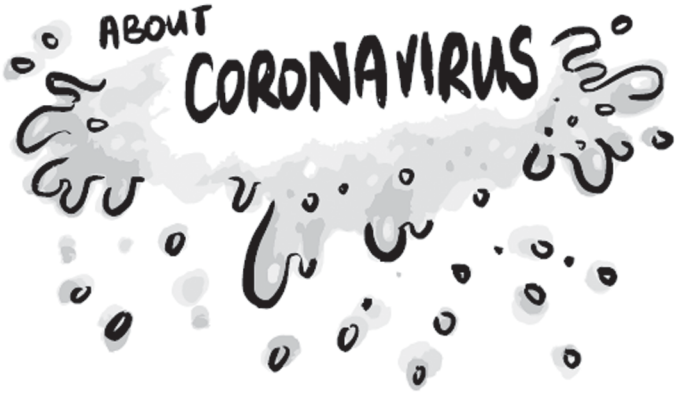
$$a^2 = 1+\sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\sqrt{1+\cdots}}}}},$$

or simply $a^2 = 1 + a$, whose solution is straight-forward (try it!):

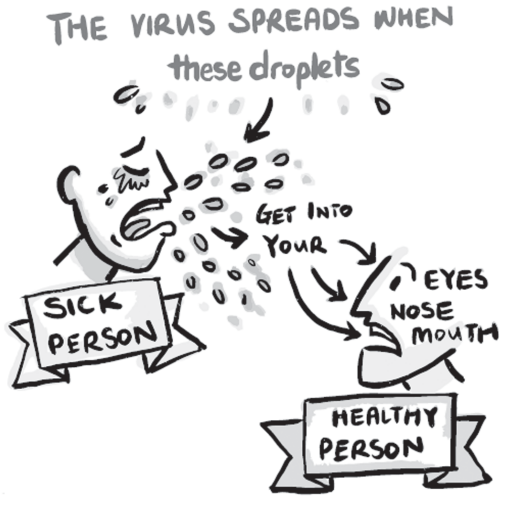
$$a = \frac{1+\sqrt{5}}{2}.$$

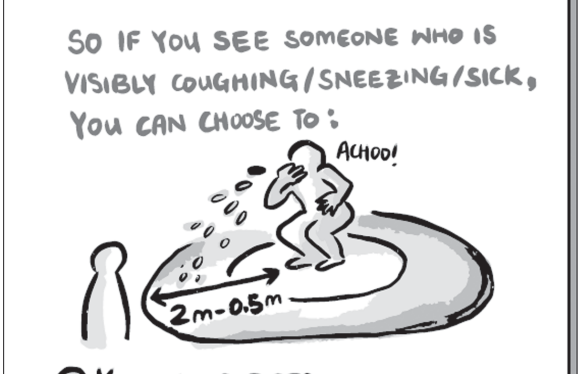
This is the famous **Golden Ratio** that was written about in the Sep-Oct, 2013, issue of JM! If you have such an old copy, you can find out that golden mean may also be written as a continued fraction involving only the number 1.

You can try to construct such examples on your own and have fun with numbers! ●





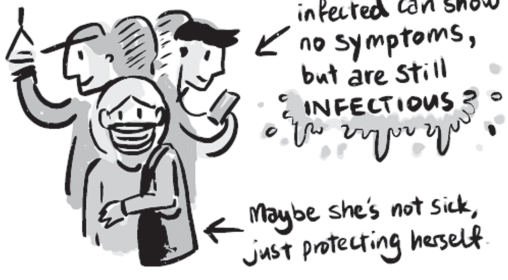



① KEEP YOUR DISTANCE.
2m to 0.5m will keep you safe
from large droplets.

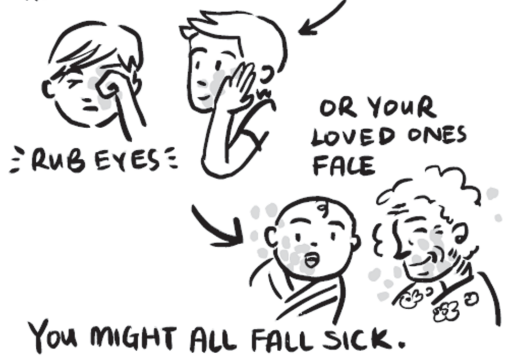

② GIVE THEM A MASK.
THEY CAN COUGH / SNEEZE INTO IT
AND PROTECT EVERYONE ELSE NEARBY

AND IN GENERAL, IT'S A GOOD IDEA TO AVOID CROWDS, BECAUSE YOU DON'T KNOW WHO MIGHT BE SICK.



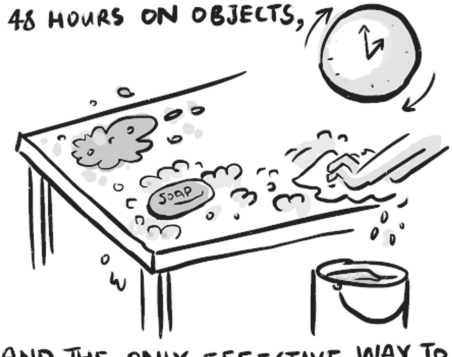

HOWEVER, SOMETIMES A SICK PERSON'S SALIVA CAN GET ON OTHER THINGS...


AND IF YOU TOUCH ANY OF THESE THINGS BY ACCIDENT, AND THEN TOUCH YOUR FACE,




YOU MIGHT ALL FALL SICK.

VIRUSES CAN LAST FOR UP TO 48 HOURS ON OBJECTS,




AND THE ONLY EFFECTIVE WAY TO GET RID OF THEM IS TO WASH THEM OFF WITH SOAP.

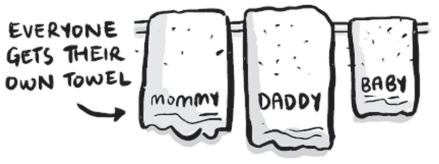
WHICH IS WHY IT IS ALSO GOOD TO FOLLOW THESE

5

PRECAUTIONS

1 WASH YOUR HANDS THOROUGHLY WITH SOAP AND WATER FOR AT LEAST 20 SECONDS AFTER TOUCHING A SUSPECTED CONTAMINATED SURFACE

3 AVOID COMING INTO CONTACT WITH PEOPLE WHO ARE SICK OR SHARE THE PERSONAL ITEMS, FOOD, UTENSILS, CUPS & TOWLES

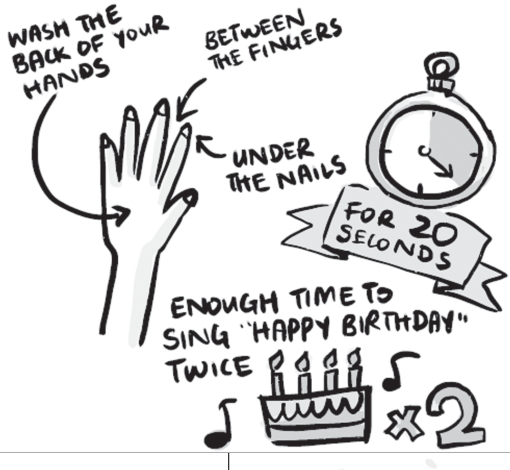



4 AVOID TOUCHING YOUR EYE, EARS AND NOSE

AND FINALLY,

5 SEEK MEDICAL ADVICE IF YOU ARE SICK

WHAT IS THOROUGHLY?




2 COVER YOUR COUGH WITH A DISPOSABLE TISSUE OR USE MASK AND DISCARD THEM IMMEDIATELY IN A WASTE BIN. DON'T WEAR THE MASK FOR MORE THAN A DAY.



*"From Siemens - Ingenuity for Life; Drawings credit: Weimankow"*

# What is a Virus?

D. Indumathi

The Institute of Mathematical Sciences, Chennai

Most bacterial diseases can be cured, usually by administering some form of anti-biotic. But viruses are different. Sometimes the disease caused by the virus gets better on its own, such as influenza (flu) or chicken-pox. Some viruses such as polio, ebola or human immuno-deficiency virus (HIV) are deadly and have no cure. The recent Covid-19 pandemic that has been caused by the SARS-coronavirus-2 is still raging across the world with no cure in sight. What makes viruses so different from bacteria?

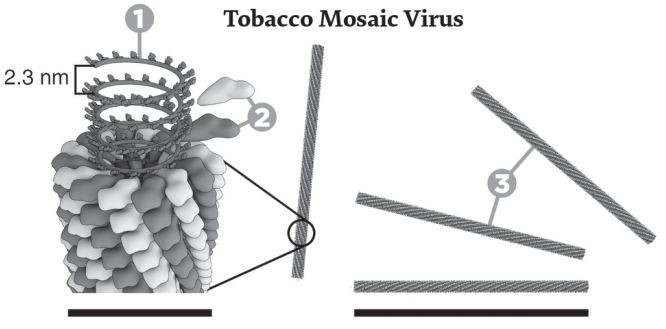
**Are they living beings?**

Unlike bacteria (or plants or animals), viruses are not cells and cannot replicate (multiply) on their own. In fact, they show characteristics of living and well as non-living things. So viruses have to rely on another organism for energy production and reproduction, in fact, for survival.

Such organisms off which viruses live are called **host organisms**. Hosts can be plants, animals, or bacteria. When humans become the hosts, the entry and multiplication of viruses in our bodies leads to various diseases. When the virus lives off a bacteria, it is called a *bacteriophage* and is very useful in diagnosis and treatment of bacterial infections and to understand more about them. Such viruses, called *retroviruses*, replicate its genome using an enzyme called **reverse transcriptase**. They have the unique ability to insert genes into human chromosomes and are used in cloning and gene therapy to cure various diseases.

**Virus Structure**

Viruses are much smaller than bacteria and cannot be seen under a microscope. While bacteria (or cells) are microns in size (1 micron is 1 millionth of a meter, or $10^{-6}$ m), viruses are only 0.02-0.4 microns in diameter. So it was hard to isolate them. The first virus to be studied was the virus that infects the tobacco plant, called **tobacco mosaic virus**, in the 1890s. The virus



1. nucleic acid (RNA) 2. capsomer protein (protomer) 3. capsid

infects many other plants as well, and its infection causes leaves to show the characteristic "mottled" appearance with patches on them (see picture).

Only when the **electron microscope** was invented could viruses be seen and the full structure of the tobacco mosaic virus was determined by **Rosalind Franklin** in 1955.

Viruses have very simple geometrical structure. They contain the *genetic material* (which may be *DNA* or *RNA*; see Box) surrounded by a protein coat called *capsid*. Some larger ones have an additional outer coat called an *envelope*. This is very important in determining how viruses infect host cells. Some viruses can remain dormant inside the host for many years, that is, without affecting the host. The *HIV virus*, for example, can remain dormant for even 10 years. At some point, caused by an unknown trigger, the virus becomes active and causes the disease.

**Envelope or not?**

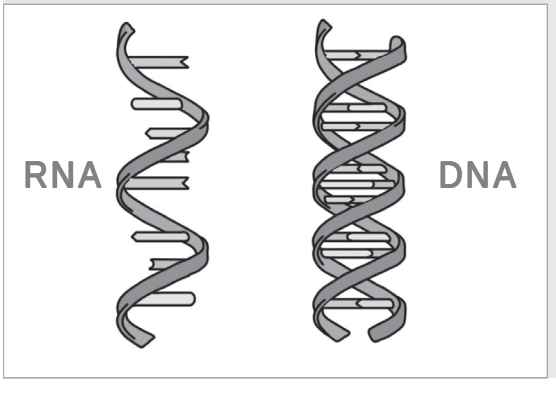
All viruses have a protein coating or capsid, but some viruses, such as the flu virus, have an additional envelope made of **lipids** (fats). Viruses without this extra membrane are called *naked viruses*. The presence or absence of an envelope is an important determining factor in how a virus interacts with the host's membrane, how it enters a host, and how it exits the host after maturation. The novel SARS-Coronavirus-2, for instance, has an envelope.

**Viral replication**

Viral replication is how the virus multiplies in

## DNA versus RNA

DNA stands for de-oxy-ribo-nucleic acid while RNA stands for ribo-nucleic acid. They are very similar except that DNA is a double stranded molecule wrapped around in a helical structure like a plait with 2 legs while RNA is a single-stranded molecule. You may have heard that DNA contains the genetic code and is inside the nucleus of all living cells. RNA has a completely different function and is typically used to carry information from the DNA to the outside of the cell (called cytoplasm) to give instructions on making proteins.



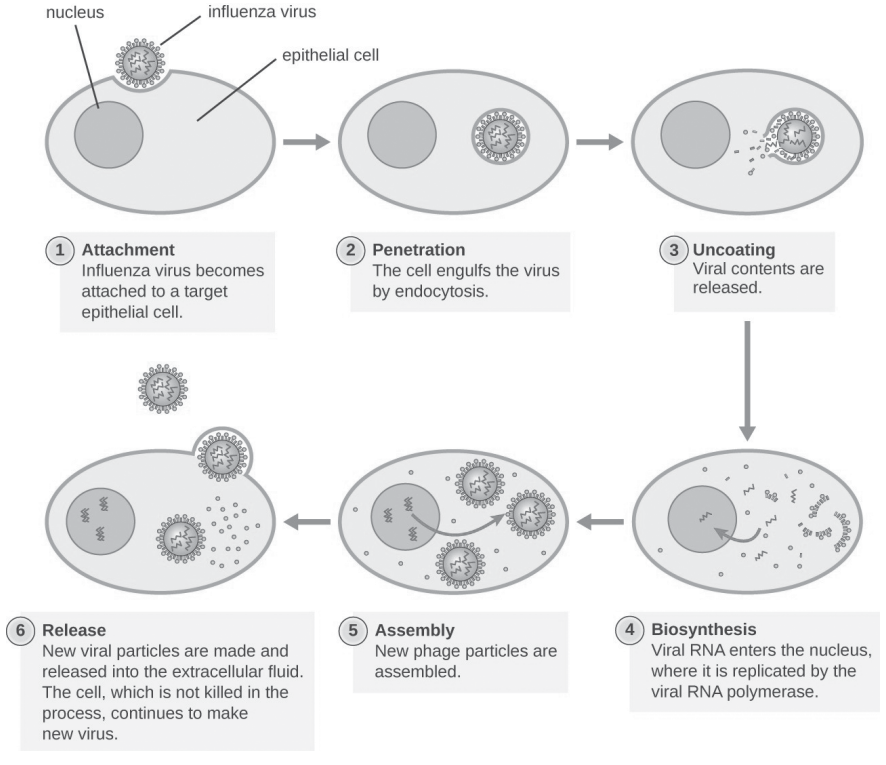

Human have 23 pairs of chromosomes. Actually, a chromosome is just a chain of DNA, which has been tightly coiled around proteins called histones and made compact so it fits inside the nucleus. Bits of DNA code for different proteins. These bits are called genes and their function is very specific; one gene produces or codes for only a specific protein.

So, the function of DNA is to self-replicate and store genetic information, while that of RNA is to store information on proteins.

the human host cells during the infection process.

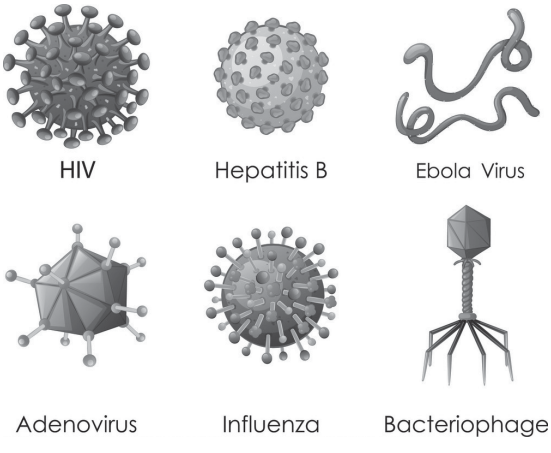
The first thing to understand is that viruses cannot propagate through cell division, since they are a-cellular. So if there is a virus in the air around you, it simply stays there. It cannot do anything, until it enters a host or target cell. For instance, this may be your own (or any human) cell. Once it does this, it uses the machinery — including the proteins, nucleic acid, and energy for the process — of the host cell to replicate, or make copies of itself.

Most DNA viruses assemble in the nucleus while most RNA viruses develop outside, in the cytoplasm.




The virus attaches to the cell membrane of the host cell. It then injects its DNA or RNA into the host to initiate infection.

Cell enzymes strip off the capsid or virus protein coat, thus exposing the DNA or RNA. The virus RNA produces messenger RNA (mRNA). The mRNA is used to instruct the host cell to make virus components. This is then used to make copies of itself, by putting the virus proteins and RNA/DNA together together in a sort of self-assembly process. What is formed is called a **virion**. It is simply an active or intact virus particle.




This replication may take place in the cell's nucleus, cytoplasm or at plasma membrane for most developed viruses, but so far all these virus copies are still inside a host cell. In order to infect you, they have to be released from the cell. This is usually done by killing the cell by bursting its cell membrane and is called **lysis**. If the virus has an envelope, then the new virus copy first acquires the envelope and then leaves the host cell by budding (see figure). In this case the original cell does not die. However, many viruses, once they infect a cell, cause it to die eventually.

In the case of the *human papilloma virus* (HPV), for instance, it causes cancer.

Viruses multiply quickly because they have so few genes. The *influenza* (flu) virus has only 8 genes, and the *rotavirus* which causes diarrhoea in small children, has 11. Humans have more than 20,000 genes.

**How they were found**

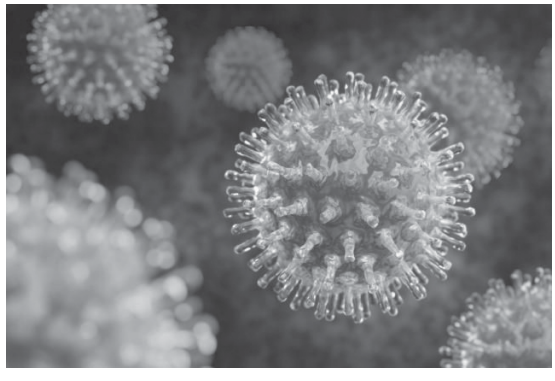
Viruses were first isolated when electron microscopes were invented. The **tobacco mosaic virus** (which infected the tobacco plant) was first examined under the microscope and found to be made up of mostly protein. Later it was found to be made of protein and RNA. Can you think how they grew the virus in the lab? After all, viruses are not living things. We know that eggs are full of protein! In 1931, scientists Ernest Goodpasture and Alice Woodruff grew the influenza virus in chicken eggs. Today, more than 5000 different viruses have been found, in all corners of the Earth, and, as we know, we are finding new ones all the time, like the SARS-Cov-2 virus.

**Infection from viruses**

Viruses are the cause of many human diseases including **influenza**, **chickenpox**, and the **common cold**. They can also remain dormant (quiet, not doing anything) in the host for a long time. For instance, the *Human Immunodeficiency virus* (HIV) can remain dormant for ten years.

**Influenza viruses**

The common cold is caused by the *rhino virus*, while influenza or flu is caused by the *influenza virus*. There are four types of influenza virus, of which types A, B, and C can infect humans. While type D infects pigs and cattle, they have not yet infected humans. Of the remaining three, types B and C are rare. You may have heard of some of the type A viruses, such as H1N1 (causes *swine flu*) and H5N1 (causes *bird flu*) which have already caused a lot of disease in the world over the years. The flu viruses have an envelope and are transmitted by the infected person sneezing and coughing, just like with the corona viruses. Rhinoviruses do not have an envelope and are really small, about 0.03 microns, while flu viruses are about 0.1 microns. You may have seen pictures of the corona virus, with the "spikes". These are actually proteins, and the influenza virus has them too.



**Corona viruses**

These are also enveloped viruses, like flu viruses and also cause respiratory tract infections similar to common cold and influenza. In fact, it is very difficult to tell which virus you have! There are many types of corona viruses, and some of them (human coronavirus 229E and OC43) just give you a common cold. Some of them are more deadly and you may have heard of them: **SARS-Cov** (identified 2003), **MERS-Cov** (2012), and **SARS-Cov-2** (2019). All are similar in size to the influenza virus, and also have the spike proteins that give the viruses their name (corona means *crown*).

All of them involve *respiratory tract infections*, and hence the name: **Severe Acute Respira - tory Syndrome** or SARS. (MERS stands for Middle-East Respiratory Syndrome and was so called because it was identified in Saudi Arabia in 2012 and then spread across the middle eastern

countries. The infection was passed by camels to humans. This was a deadly disease but was brought under control mainly because it did not spread directly from humans to humans).

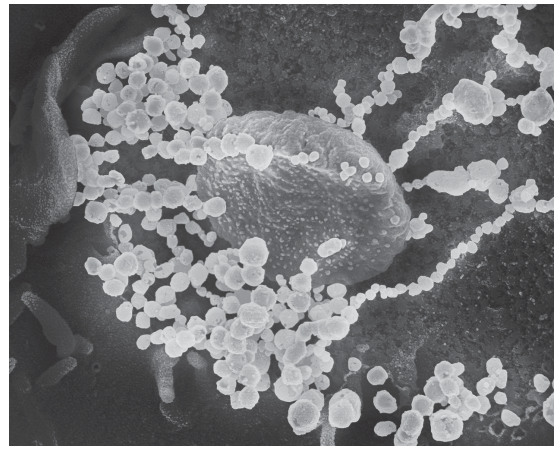
**History repeats itself**

The SARS-Cov pandemic began in Nov 2002, and ended by the end of Jun, 2003. By this time, more than 8000 people from various countries across the world were infected and 774 died, including the Italian doctor, **Dr Carlo Urbani**, who first identified that it was a new virus and a new disease. He reported it to the World Health Organisation (WHO) and also recommen -ded isolation and screening measures for travelers, thus slowing the spread of the disease.

SARS-Cov was passed by bats to humans, and then from human to human. Hence it was more of a danger, although the death rate (mortality) was much lower than MERS. However, the virus spread was controlled by isolation and quarantine. Preventive measures included handwashing well with soap and water, cleaning surfaces regularly and disinfecting them, and other simple basic hygiene measures. In short, everything that is being recommended for SARS-Cov-2 was also tried successfully for SARS-Cov in 2003! There is still no cure for either SARS-Cov disease. Only isolation, testing, and physical distancing seem to work to control the spread of this disease.

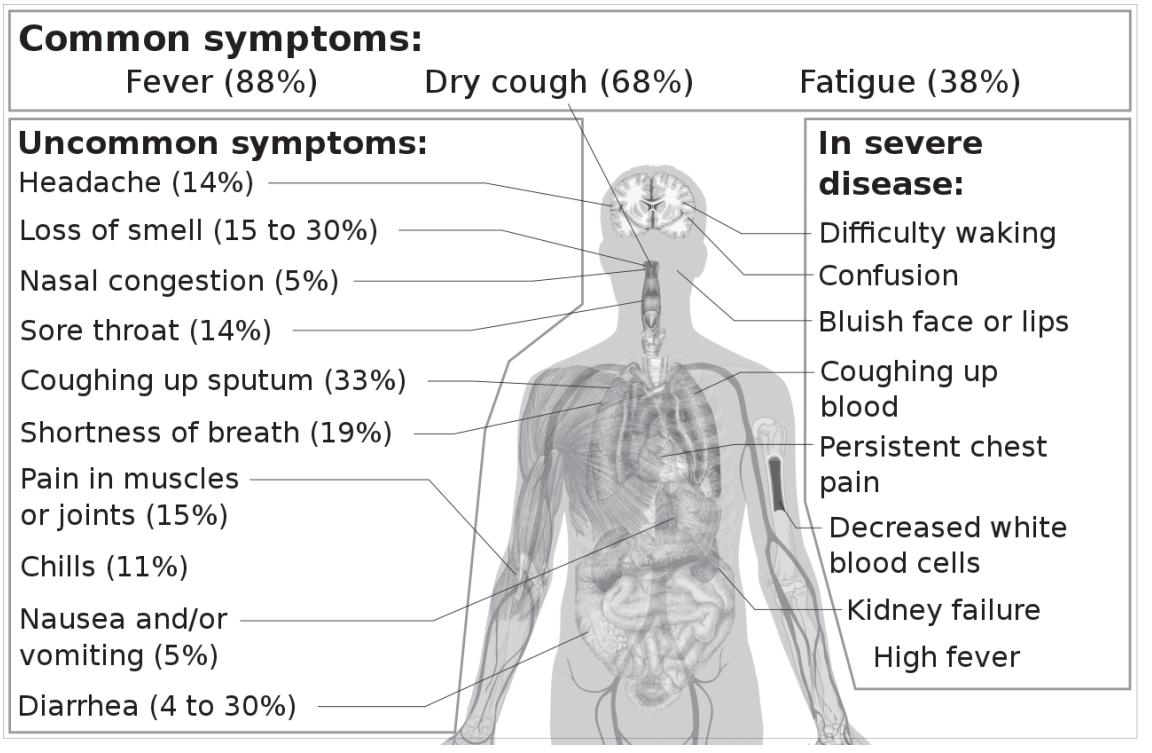
**SARS-Cov-2 and Covid-19**

The SARS-Cov-2 coronavirus is similar to the SARS-Cov virus and causes the Covid-19 (corona virus disease 2019) disease. It is also found in bats. The picture shows how the viruses look like under a scanning electron microscope. The SARS-CoV-2 viruses are seen as the round shining gold objects emerging from the surface of human cells cultured in the lab. The virus shown was isolated from a patient in the U.S. (Credit: NIAID-RMLH).



However, it appears to be much more infectious than SARS-Cov. The disease is spread mainly by breathing in droplets from infected persons who are coughing and sneezing. The main difference between this and SARS-Cov is that the infected persons are infectious much before they show symptoms, which can take 2-14 days. So it is possible that this person can infect many others before he or she are isolated. In contrast, people sick with SARS-Cov became infectious only a few days after they showed symptoms, so it was easier to isolate them and prevent the disease from spreading.

The *viral load* in an infectious person is the amount of virus that the person has in his mucous or other body fluids. This load is largest in the earliest time of the SARS-Cov-2 infection, and then decreases over time. Again, this makes the person who has just caught the disease




extremely infectious.

**What to expect if you are sick**

The virus appears to be mostly transmitted through coughing when small water droplets carrying viral load is sent into the air which others later inhale (see picture). It is possible that the virus is also expelled from the air that is exhaled while breathing while this is not clear as yet. Viruses have been detected in stools (faeces) of patients but not in urine; again it is not considered a significant source of infection.

Most people have mild symptoms of fever, dry cough and tiredness. This begins 2-14 days after being infected. These mild symptoms can last a week or so. After about 8-10 days, some people suddenly get worse. They have breathlessness and pneumonia (lung infection) and chest pain. At this point, the patient has to be given immediate and critical care. About 80% of people get well on their own after a week or so. Some people are so mildly ill that they may not even realise they have fallen sick.

It is obvious that if a person infects more people, then the total number of persons becoming sick becomes really large. Since there is no cure for this disease, the only way to reduce the spread is to practice physical distancing and wearing a mask.

See how you can do this in the accompanying article.

In short, SARS-Cov-2 can be contained, just like SARS-Cov was, but it can only be done by community effort. So each one of us has to do our bit. The number of infections across the world has already exceeded a million and thousands have died. Let us all follow good hygiene practices and stay safe, and keep our family safe.

***Sources: Many from the internet, especially Wikipedia***

# Do You Know?

*1. According to my science textbok, sunlight is white. Then why does it appear yellow to the eye?*

*2. How is a hissing sound produced when water falls on a hot surface?*

*3. Many websites have a "Captcha" to check that a human being is using it. How does this work?*

*4. In many competitions, we often "root for the underdog", that is, support someone who would ordinarily be expected to lose. Why do we do this?*

*5. I always see wind coming from somewhere. Where does wind come from?*

**Answers to last issue's Do You Know?**

*1. I love eating ice cream. Can I survive by just eating different flavours of ice cream (and nothing else)?*

***Answer:*** The short answer is yes, you can, but it will not be a pleasant life.

Health experts recommend that women consume at least 1200 calories a day, and men consume at least 1500 calories a day. Ice cream contains milk, cream, and sugar. Let us say you have a plain vanilla flavour, it has about 200 to 250 calories per 100g, so you would need to eat at least half a litre of it each day to get enough calories. But 100 gm of icecream contains about 4 g of protein, 28 gm of carbohydrate (mostly sugar) and14 gm of fat. So half a litre of ice cream would give you only about 20 grams of protein per day, which is smaller than the 40 gm of protein that a 50 kg person needs. But milk protein contains all the ten essential amino acids your body needs. These are the amino acids that cannot be made (synthesised) by our own body and are required for normal growth and development as well as metabolic and physiological functions of the body.

Milk also contains vitamins A, D (usually added extra to toned milk), E, and K which are the fat soluble vitamins although it is not a major source of E and K. It also contains most of the B vitamins, and small amounts of vitamin C. You could take care of the rest with different ice cream flavours. If you could include real fruit pulp and nuts, instead of flavour extracts like vanilla, you should get enough vitamin C and E.

Unfortunately, an ice cream-only diet would give you too much saturated fat and sugar, increasing your risk of coronary heart disease and diabetes. You are also likely to

suffer from constipation as you will be short on dietary fibre (which come from vegetables and fruit). Your teeth will rot fast as well, so you will not even enjoy the ice cream!

So while you may be able to survive, it is not a recommended diet!

*2. Why do clothes look darker when they get wet?*

***Answer**:* Actually , wet fabric is not actually darker than dry fabric. Rather, it just *looks* darker to the human eye. The same goes for other surfaces, like wet cement after a rainstorm, or wet beach sand after waves splash over it.

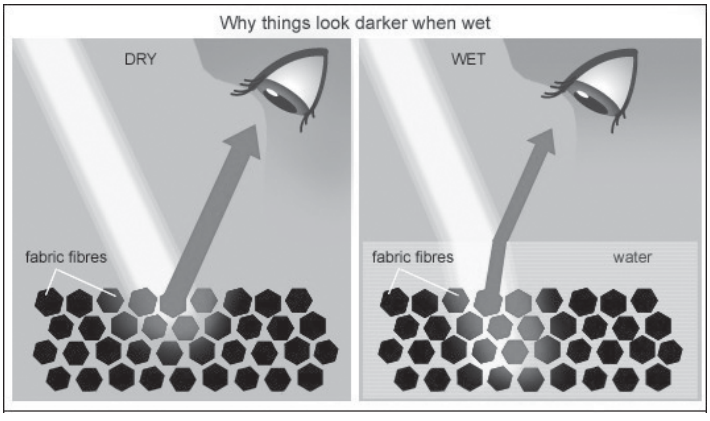
To understand how colour in material changes in the presence of moisture, it is important to recall how colours are perceived by us in the first place. When light from the sun strikes a blade of grass, we perceive the grass to be green because the light energy is only partially absorbed. The grass absorbs wavelengths of light in the blue, red, yellow and orange range of the electromagnetic spectrum, but reflects green light wavelengths (560-520 nanometres). Thus, the light that bounces back from the grass is taken in by our eyes, where it hits the cone cells in our retina, and is translated in your brain to green grass. So how we perceive colour is completely dependent on how light is either absorbed or reflected.

Additionally, the texture and composition of the material can affect how we see colour. An article of clothing is composed of many layers of tiny fibers, which provides a lot of surface area for light to be reflected. Even though a material may be partially transparent,

the multiple layers and individual fibres reflect the colour back at you. A white T-shirt, for example, is composed of fibres that are mostly transparent, but in such large numbers and concentrations, they generate a vibrant white colour. The interaction of all that fabric, light and air creates the appearance of a solid colour to your eyes. Even if fabric feels smooth, they have a rough surface on a microscopic level and the falling light has more angles to bounce off, generating more reflection and creating a brighter appearance.

Now let us examine how things change when a material or surface is wet. Most importantly, when a material is wet, that additional layer of water acts like a second reflective surface.

Consider a bright red T-shirt for example. When light strikes the dry T-shirt, all the wavelengths of light are absorbed except for those that appear red (700-635 nanometres), which bounce back to our eyes. When that T-shirt gets wet and light strikes the fabric, it must then pass back through the layer of water on the fabric. The water has filled in all the gaps of the fibres that had previously




been filled with air. As a result, the light is more likely to be bent away from the eye by the water. This condition is called total internal reflection, a situation in which the light that would normally bounce back at the observer can instead be re-absorbed by the water.

If fewer photons of light bounce off the fabric and return to your eye, then the material appears to be "darker" in colour. The amount of light being reflected by the material is the same, but less of it is being sent back to your eye.

As the fabric dries, more air returns to the pockets of space between the fibres, allowing falling light to bounce and reflect more freely, rather than being absorbed or re-reflected by any water present on the material. So the colour becomes "lighter".

*3. Can we genetically modify an animal so that it could live on another planet or on the moon?*

***Answer:*** This is an interesting question. Firstly, rather than animals, if we consider bacteria, there may already be microbes on Earth that could survive on **Mars**. Bacteria from the Dead Sea and the Arctic tundra have been shown to survive in a simulated Martian atmosphere. **Venus** has a cooler upper atmosphere, but surviving on this planet is difficult, as it has no ice or water.

Alien life might have its own completely different biochemistry, but we would not be able to genetically engineer it, since DNA molecules themselves require water.

Moving on to more complex, multicellular life, the lack of atmospheric oxygen on Mars would probably rule out this planet. The organisms on Earth that do not need oxygen are almost all single-celled because anaerobic metabolisms produce much less energy.

**Jupiter's moon Europa** has a liquid water ocean underneath its icy crust, and in 2009, some scientists suggested that there might be oxygen too. How survivable this ocean is for Earth life will depend on what other toxins and nutrients are dissolved in it. If we do wish to attempt genetic engineering to survive the cold and pressure in Europa, deep-sea fish and invertebrates would be good candidates.

How do scientists study the mechanisms by which human beings might survive in environments outside the Earth? In 2015 there was a study of the Kelly twins, one of whom spent more than a year aboard the *International Space Station* while his twin brother stayed back on Earth. From this study scientists have obtained a wealth of data on how space affects the human body. The


major question in this line of research is to figure out a way to make human cells more resilient to the effects of radiation.

However, the idea of tinkering with animal genes is controversial, so nobody has a definite answer to the question.

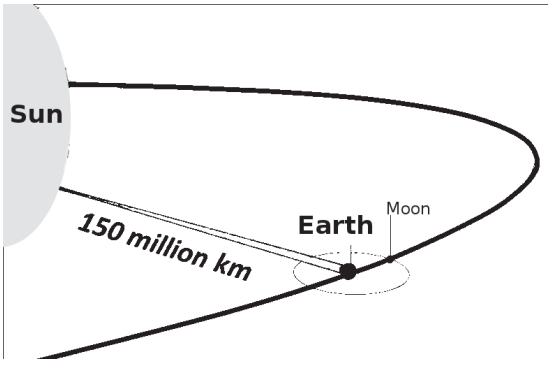
*4. Do fish feel pain?*

***Answer:*** This has been debated for a long time and people have believed for long that fish do not suffer. But in the last two years, scientific evidence is coming in showing that this wisdom might be faulty.

Fish have neurons known as *nociceptors*, which detect potential harm, such as high temperatures, intense pressure, and caustic chemicals. Fish produce the same *opioids* (the body's innate painkillers) that mammals do. Also, their brain activity during injury is analogous to that in vertebrates on land: sticking a pin into **goldfish** or **rainbow trout**, just behind their gills, stimulates nociceptors and a cascade of electrical activity that surges toward brain regions essential for conscious sensory perceptions (such as the cerebellum, tectum, and telencephalon), not just the hindbrain and brainstem, which are responsible for reflexes and impulses. So fish do demonstrate a sharp reaction.

Fish also behave in ways that indicate they consciously experience pain. In one study, scientists dropped clusters of brightly coloured Lego blocks into tanks containing rainbow trout. These trout typically avoid any unfamiliar object coming suddenly, in case it is dangerous. But when scientists gave the rainbow trout a (painful) injection of acetic acid, they were much less likely to exhibit these defensive behaviour, probably because they were distracted by their own suffering. In contrast, fish injected with both acid and morphine maintained their usual caution. Like all analgesics, morphine dulls the experience of pain, but does nothing to remove the source of pain itself, suggesting that the fish's behaviour reflected their mental state, not mere physiology. If the fish were reflexively responding to the presence of caustic acid, as opposed to consciously experiencing pain, then the morphine should not have made a difference.

In another study, rainbow trout that received injections of acetic acid in their lips began to breathe more quickly, rocked back and forth on the bottom of the tank, rubbed their lips against the gravel and the side of the tank, and took more than twice as long to resume feeding as fish injected with benign saline. Fish injected with both acid and




morphine also showed some of these unusual behaviour, but to a much lesser extent, whereas fish injected with saline never behaved oddly.

Should we care how fish feel? Philosophers discussing our ethical obligations to other animals say, yes, if we know that they suffer. Though we do not know whether cats, dogs, lab animals, chickens, and cattle feel pain the way we do, yet we still afford them increasingly humane treatment, so the considerations may apply to fish as well.

*5. How far do we travel through space every day?*

***Answer:*** The first and simple answer is found by calculating the circumference of the Earth's orbit around the sun and dividing by the number of days in a year.

The average distance from the sun to the Earth is 150 million kilometers. Multiplying by 2 pi (where pi = 3.1416) gives 942.5 million km for the circumference. Dividing this by 365.25 days/year gives 2.58 million km per day. Dividing by (24 hours x 60 minutes x 60 seconds) in a day, this gives us 29.86 km/second!

The actual average orbital velocity is closer to 29.77 km/second, accounting for the fact that the orbit is slightly elliptical. Using this value gives a more accurate 2.57 million km per day average.

Actually this apparently simple question also touches on some fundamental principles of relativity and even questions in cosmology. There is no universal reference frame. So, when talking about the motion of the Earth, we have to declare which object the motion is with respect to. At the Earth's equator you travel approximately 40,000 km a day with respect to the Earth's centre. Each day, the Earth's orbit takes you about 4.02 million kilometres with respect to the Sun's centre.

Our solar system is in motion relative to the Milky Way galaxy and our entire galaxy, along with the local cluster of galaxies is in motion relative to the Cosmic Background Radiation. This last motion is measured by observing a red-shift in the background radiation.

The entire solar system, including the Earth, moves through the "cosmic background radiation" (the leftover radiation from the birth of the Universe) at about 596 km per second for a total of 51.5 million km per day. This is much larger than the orbital motion, but it is not yet known what is the cause or meaning of this relative velocity. (To be precise, the directions of all these velocities are always changing, it is meaningless to simply add them together since velocity is a vector and the directions matter.)

***Sources: BBC's Science Focus, Physics Links, ABC Science, Hakai magazine***


# Alice in Puzzleland

*D. Indumathi*

**The Institute of Mathematical Sciences, Chennai**

Have you read ***Alice's Adventures in Wonderland***? Written more than 150 years ago by **Lewis Carroll**, it is the highly imaginary and imaginative story of a young girl called Alice who dreams that she has followed a talking rabbit through a rabbit hole and finds a fantastic world peopled by strange and peculiar creatures. If you haven't read it, you must try and find a copy of the book.

The story is appealing to both children and adults; one unusual theme is that Carroll uses ***logic*** to make sense of the fictional world. Carroll later wrote a sequel called ***Through the Looking Glass*** where Alice climbs through a mirror into a world of opposites, still with its own strange logic.

The sketch in the Google "doodle" shows Alice as the "L" in Google, and was published in February this year as a tribute on the 200th birthday of Sir John Tenniel. Tenniel had beautifully illustrated the book of ***Alice***. The famous ***Cheshire cat*** that can disappear, leaving only its smile behind, is also shown. Also see one of Tenniel's illustrations of a caterpillar using a hookah.

Several writers have been inspired by ***Alice***. One of the most famous is the logician and popular writer **Raymond Smullyan**. Smullyan is well known for his popular books on logic puzzles and he has based his entire book ***Alice in Puzzleland*** on the characters in ***Alice***, especially the White Queen and the Red King (who are all from a pack of cards!)

*Read on for a few of the puzzles from this book. The first three are simpler algebra and the logic puzzles follow.*

Let's start with an easy one. How much is a


million divided by a quarter? (Ans 1 below).

A bottle of soft drink costs Rs 30. The soft drink costs Rs 26 more than the bottle. How much is the bottle worth? (Ans 2 below).

A certain farmer had no money to pay his taxes. So the tax collector took one tenth of his land away from him. After the land had been taken, the farmer had 10 acres left. How much land did he originally have? (Ans 3 below).

*Tweedledum* and *Tweedledee* had a bet. Whoever won the bet would get one baby rattle toy to add to their collection of rattles. Tweedledum realised that if he loses the bet, he will have the same number of rattles as Tweedledee. If he wins the bet, then he will have twice as many rattles as Tweedledee. How many rattles does each one have? (Ans 4 below).

The *White Queen* said, "Whenever the *Red King* is asleep, everything he believes is wrong. On the other hand, everything he believes while he is awake is true. Well, last night at ten o' clock sharp, the *Red King* believed that both he and the *Red Queen* were asleep at that time. Was the *Red Queen* asleep or awake at the time?" (Think carefully about what is being asked. See Ans 5 below).

The *Red Queen* said, "I am like the *Red King*. I also believe only false things when I am asleep and believe only true things when I am awake. Now, last night at 11 o' clock, the *Red King* believed I was asleep. At the same time, I either believed that he was asleep or I believed that he was awake. Which did I believe?" (Ans 6 below).

The White Queen said, "Here is a true story. I once had to post four letters. I had written then, and had the four envelopes correctly addressed, but I was careless and put some of the letters into the wrong envelopes. However, I put only one letter in each envelope. As it happens, I either got three of them exactly right, or I got exactly two of them right, or I got exactly one of them wrong.

How many did I get right?" (Ans 7 below).

**Answers to the puzzles**

***Ans 1.*** A million divided by a quarter is 4 million (not a 1/4 million since you are dividing, not multiplying).

***Ans 2.*** Let the bottle cost B=Rs X. Then the drink D costs Rs 26 more, or D=26+X. The bottle and drink together cost Rs 30. So B+D=30, or X+(26+X)=30, or 2X=4, or X=2. The bottle costs Rs 2.

***Ans 3.*** Let the farmer have X amount of land. One tenth of this is taken away, so (9/10) of it is left. This equals 10 acres, or (9/10)X=10, or X=100/9 or the farmer had 11 and 1/9 acres to start with.

***Ans 4.*** Let Tweedledum have X rattles and Tweedledee Y rattles. If Tweedledum loses, Tweedledee gets an extra rattle, so he will have (Y+1) rattles, and this will equal what Tweedledum has. So X=Y+1. If Tweedledum wins, he gets the extra rattle and this will be twice what Tweedledee has, or X+1=2Y. Replace X=Y+1 from the earlier statement to get (Y+1)+1=2Y, or simplifying, Y=2. So X=Y+1=3.

***Ans 5.*** If the King was awake, whatever he believes is true. So he could not have believed that both he and the Queen were asleep. So he must have been asleep. But then whatever he believed must be false. He believed that both of them were asleep and he was in fact asleep. So the only way for this statement to be false is if the Queen was awake. So the Queen was awake.

***Ans 6.*** This is a little more complicated. We have to analyse the cases for both the King being asleep or awake and the Queen being asleep or awake. Let's start with the King. He believes that the Queen was asleep. Suppose he was asleep but since he is asleep this belief is false. So the Queen was actually awake. On the other hand, if he was awake, then what he believes is true. So

the Queen was actually asleep.

With this information in mind, let us analyse the Queen's beliefs. She either believes that (1) the King is awake or she believes that (2) the King is asleep. She does this while either asleep or awake.

Let us start with the possibility that the Queen is asleep. Suppose she believes (1), that the King is awake. Since she is asleep, this is false, so the King is actually asleep. So what the King believes (that the Queen is asleep) is false. So the Queen is awake, but that contradicts our starting point that the Queen is asleep. So this combination is ruled out. What if she believes (2), that the King is actually asleep. She herself is asleep, so this belief is untrue. So the King is

actually awake, and when he is awake, his belief (that the Queen is asleep) is true and this is consistent with our starting point that the Queen is asleep.

Now let us consider the possibility that the Queen is awake. Suppose she believes (1), that the King is awake. Since she is awake, this belief is true, so the King is indeed awake. Hence the King's belief (that the Queen is asleep) is true but this contradicts our starting point that the Queen is awake. So let us try the other belief, that she believes (2), that the King is asleep. Since she is awake, this belief is true. So the King's belief (that the Queen is asleep) is false, and so the Queen is awake, which is consistent with our starting point.

So in the two cases we have analysed that are consistent, the King is awake and the Queen is asleep, or the King is asleep and the Queen is awake. In the first case, the Queen is asleep and her belief is untrue. Since the King is awake, she must believe the opposite, that the King is asleep.

In the second case, the Queen is awake and her belief is true. Since the King is asleep, she must believe that the King is asleep.

Have you noticed: in both cases, the Queen believes that the King is asleep!

***Ans 7.*** This is simple. If you had put three letters correctly in their envelopes, then the last letter has to go into the last envelope so it is not possible to get three right and one wrong. Similarly, getting exactly one wrong means getting three right, and we just saw that this is impossible. So she must have got exactly two of them right and the other two were swapped.

***From Alice in Puzzleland, by Raymond Smullyan***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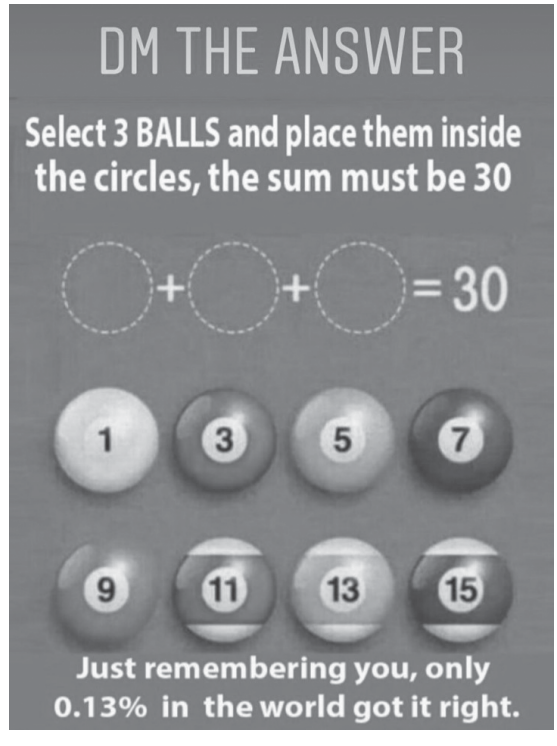


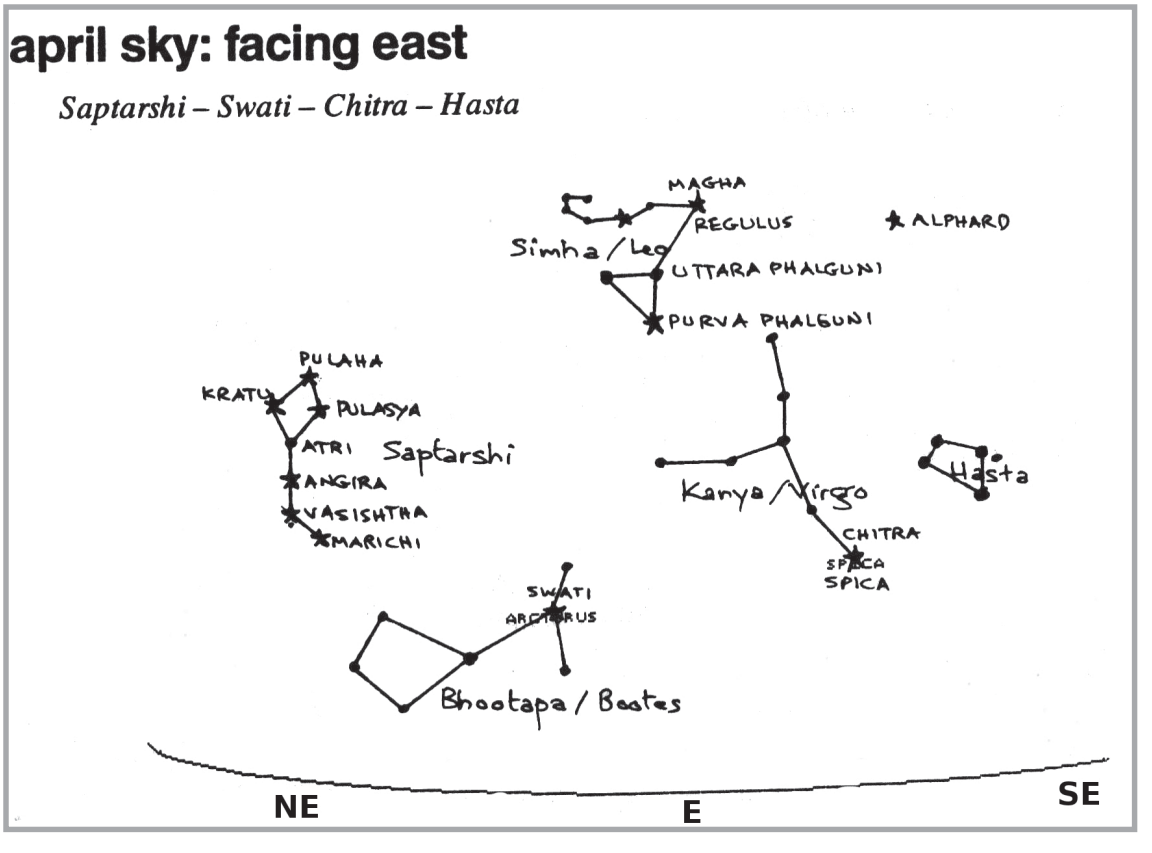
# Nightskywatching

*Kamal Lodaya*

Every issue, ***JM*** has a map of some stars seen during the month, with a small explanation. Take this map to a place where the sky when you face East is dark and there are no lights in that direction. East is where the Sun rises in the morning.

***The map shows stars seen at 9 pm on April 1st, or at 8 pm on April 15th, or at 7 pm on April 30th.*** Take a few minutes to let your eyes get adjusted to the darkness. Then you will start seeing stars. Use a small torch (maybe from your phone) covered with red paper to give a soft red light to the map. Red light interferes least with your ability to see things in the dark.

The bright yellowish star (**vinmeen**) that you see in front of you, twinkling above the Eastern horizon, is called **Swati** in India and **Arcturus** in English. To its left and higher, if you turn towards the North, you will find a large constellation with four stars forming a



*quadrilateral*, and then a curving arc of three stars. Following that curve towards the East brings you to Swati.

Those seven stars have names: in order, *Kratu, Pulaha, Pulasya, Atri, Angira, Vasishtha* and *Marichi*, seven rishis, and the constellation is called **Saptarshi**. In English it is called the **Great Bear**, with the quadrilateral forming its body and the three stars in the curve a tail. (Do bears have tails?) It is one of the best known constellations; you might even find someone who knows it and can show it to you.

Following the curve you come to **Swati**. Follow the curve some more and you come to **Chitra**, a bright white star. Chitra is in the constellation *Kanya* or the *Young Girl*. Follow the curve a bit more and you reach the little constellation of **Hasta**, known as the *Crow* in English.

If you follow the line **Atri-Pulasya** for a long distance, you will have to crane your neck overhead to find **Magha** or *Regulus*, the brightest star in the constellation of **Simha** or the *Lion*. With the help of the map, see if you can trace its shape. To the left of Magha is the head of the lion, and its body is in the direction of Kanya. Two stars marked on the map are **Uttara Phalguni** and **Poorva Phalguni**.

### Did you get all of that?

We constructed a large pattern of stars going from the North of the sky to the East and even a bit further.

### Do You Know?

In many Indian languages, the word **nakshatra** is used for stars. But some stars are special, and they were called nakshatras in our history. *Magha, Uttara Phalguni, Poorva Phalguni*, the little *Hasta, Chitra* and *Swati* are nakshatras. The other stars (such as those of the **Saptarshi**) are not nakshatras. What is special about these nakshatras?

Some constellations are called **rashis**. *Simha* and *Kanya* are rashis. **Saptarshi** is not a rashi. What is special about these rashis?

**Activity:**

On 1st April there was a *half Moon*. If you faced East on 1st April, it should have been high up above you. In the next few days, as the phase of the Moon became bigger, it would have come into the Eastern sky, lower and lower. On 7th February was *Purnima*. The super pink **Moon** rose above the Eastern horizon below **Swati**.

If you can recognize the stars we talked about, mark the position of the Moon on the map every day. You will then find out for yourself the answers to the questions we asked.

## Can you recognize the Western sky?

If you look at the Western sky, can you recognize the hexagon we outlined in the Jan-Feb issue of ***Jantar Mantar***? The three stars forming the belt of *Orion* (**Mriga**), with orangish *Betelgeuse* (**Tiruvadirai**) and white *Rigel* (**Rajanya**) on two sides of it?

If you follow the belt to the left you reach *Sirius* (**Vyadha**). If you follow the belt to the right you reach the yellowish *Aldebaran* (**Rohini**) in *Taurus* (**Vrishabha**).

But what is this bright star dominating the scene in *Taurus*, brighter even than *Sirius*?

This is not a star, it is the planet *Venus* (**Shukra, Velli**). It is at its highest after sunset at the end of March. It is at its brightest at the end of April.

If you have kept your star map from the previous issue, you can mark the position of *Venus* once a week. The word "planet" means a wanderer, and you will be surprised to see that *Venus* moves very slowly through *Taurus* (**Vrishabha**).

***Questions:*** Please send questions and experiences about your night sky watching to ***JM***.

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# Sleeping underwater

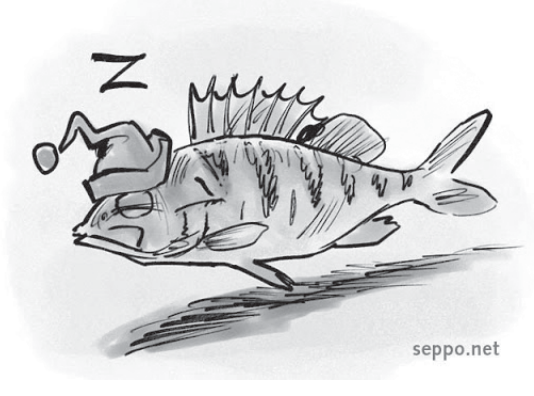
S.Narayani

All of us are familiar with this threat that our mothers use in the morning : "It is getting late. If you are not waking up now, I will pour water on you!"

Have you ever wondered about the sleep patterns of animals that spend their entire lives underwater? How, where and when do they sleep? What about the aquatic mammals that need to come to the surface to breathe oxygen? Let us dive inside and learn, shall we?

**Function of sleep**

While we try to understand how sleep occurs underwater, we also have to understand why sleeping is important. Why do animals need sleep? Scientists say that one of the important functions of sleep is to allow the brain to consolidate all the events of a day and make them into memories. During sleep, the external stimulus or new sensory input is shut down, so the brain is free to form memories. Sleep is essential for a healthy brain.




This raises two questions: (1) Does sleep occur only in animals with advanced brains? (2) Are there fishes that do not sleep? If so, how do they consolidate their memories?

**Does sleep occur only in animals with advanced brains?**

Researchers in Caltech University conducted a study in 2017 and demonstrated that jellyfishes sleep. The sleep period was indicated by a period of low responsiveness and pulsing. The jellyfishes in their experiment slept upside down. This research broke the long-held idea that only advanced animals sleep. It has been shown now that sleep is necessary for all animals, including those with primitive nervous systems. Researchers have found out that snails, fruitflies and even worms need sleep!

**Are there fishes that do not sleep?**

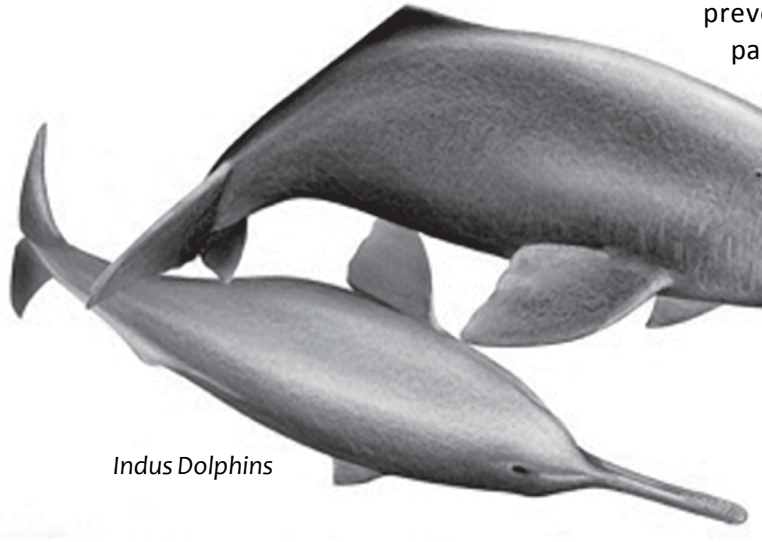
There are some fish species that do not sleep. Fishes living in caves, fishes that swim in groups and some species of open ocean fishes do not sleep at all. What happens to their memories? Scientists have given the theory that their habitats like caves and open oceans do not provide them with a heavy sensory input. Since they receive only a small sensory load everyday, their brains can consolidate those memories even without rest. The brain processing can happen in the background while the fish is moving.

**Sleep in fishes**

When we talk about sleeping in primitive vertebrates such as fishes, we have to redefine our understanding of "Sleep". The

oxford dictionary defines sleep as “the natural state of rest in which your eyes are closed, your body is not active, and your mind is not conscious”. All of these criteria have to be modified to understand sleeping in fishes.

Fishes do not have eyelids, so they cannot close their eyes. Some fishes need to keep moving continuously to take in oxygen, so sleep cannot be defined as a period of complete inactivity. Fishes live in the wild, so we cannot say that the mind is not conscious during sleep. If they fully lose consciousness, they become vulnerable to attacks by bigger species.



*Indus Dolphins*

In fishes, sleep can be defined as period of low responsiveness, a slowed metabolic rate and a state of reduced activity.

These are the possible ways in which various fishes have been observed to sleep:

- Drifting (slowly moving without swimming)
- Hovering near the water surface
- Hovering near the bottom
- Hiding under rock and moving very little
- Creating nests and sleeping in them
- Sleeping while in schools or fish groups - some fishes will stay active and act as watchmen, while the other fishes sleep safely

**Parrotfishes** create a cocoon or nest made of mucus and sleep inside them. At night, the predators in coral reefs hunt using smell, so if a parrotfish sleeps in the open, there is a risk of being exposed to predators. A cocoon prevents the predators from smelling the parrotfish and keeps it safe.

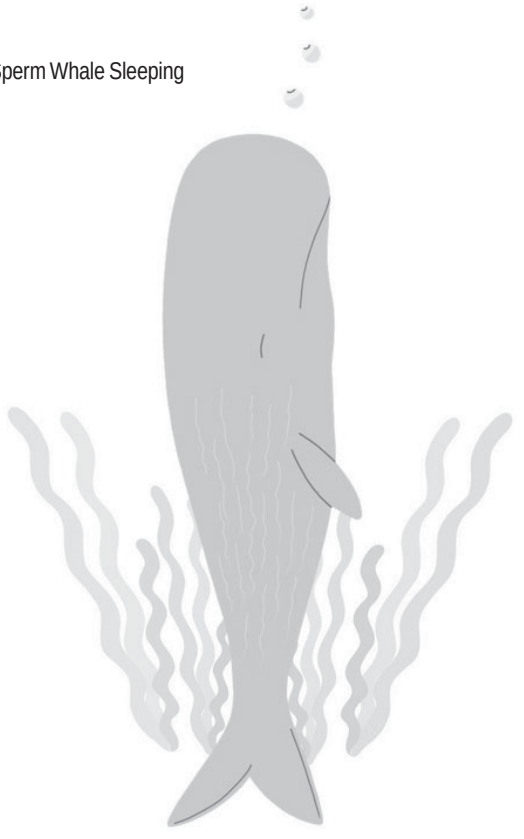
Fishes may look inactive, but they are alert when they sleep. But some species of fishes can be such sleepyheads, we can lift them by hand all the way to the surface when they are sleeping!

**Periods of No-sleep**

Eventhough sleep is very important, it is not possible to get a healthy sleep cycle all the time. Fishes do not sleep during migration and spawning. Some species of fishes do not sleep when they are caring for their young ... and the same can be applied to humans also!

Some species of aquatic animals do not sleep when they are young, they start sleeping only when they become adults. New born orcas (also called killer whales) and tilapia are best examples for this phenomenon. Researchers are trying to understand how the fishes manage during these no-sleep periods.

Sperm Whale Sleeping



**Aquatic mammals**

Sleeping underwater can be easy for fishes. But for mammals who need to come to the surface to breathe oxygen every few minutes, sleeping can be a very risky activity. Many aquatic mammals exhibit "unihemispheric sleep", meaning only one hemisphere of the brain is inactive during sleep. The other hemisphere helps the animal in swimming and breathing and the sleeping hemisphere gets rest.

A species of **Indus Dolphin** exhibits "Microsleep", in which, instead of sleeping for long times, it sleeps for only a few seconds at a time. If all the seconds are added together, a dolphin gets 7 hours of sleep per day!

**Walruses** have airpockets inside the oesophagus, helping them to float in the water when they sleep. **Sea otters** sleep floating in the water while holding hands to make sure that they do not swim away.

Perhaps the oddest sleeping pattern in the aquatic world belongs to the **sperm whale**. In 2008, a diver spotted a group of sperm whales in upright position, completely motionless. Later, the phenomenon was explained by the researcher *Patrick Miller* from *University of St. Andrews*. Like the Indus dolphins, sperm whales also exhibit micro sleep. But instead of a few seconds, they sleep for 15 minutes at a time while maintaining a vertical position. Then they start swimming again. If we add up all the small naps that spermwhales take, they seem to get only 1.5 hours of sleep per day! This makes spermwhales the recordholders for sleeplessness, spending only 7% of the day in sleep! It is said that the upright position is possibly relaxing to sleep in, since they have a very big bony head. Sleeping in the group could be for safety against predators.

So next time you hit the snooze button in your alarms, think of all these fascinating sleeping modes and be grateful that you do not have to worry about big angry predators even during sleep!

Images from the net, including https://www.mattressclarity.com and https://photobackstory.files.wordpress.com ●

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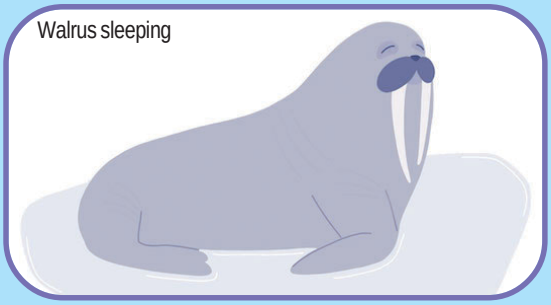




*Parrotfish sleeping in their cocoon of mucous*

*Back Cover: Sleeping sea otters (Enhydra lutris) holding hands, photographed at the Vancouver Aquarium, Canada; from Wikimedia Commons. Jelly fish sleeping upside down. Photo from article by Dr Christie Wilcox, https://qz.com/.*

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