

# In The News The Clocks within: 'CIRCADIAN RHYTHMS'

Dr. Yasmin Khan, Vice Principal, (Science), Sophia College, Mumbai.

As happens every year, in September, the announcement of the Nobel Prizes makes important news. The highest accolade that a scientist can receive for their work is the Nobel Prize. This year the Nobel Prize in Medicine and Physiology was given to three scientists, Jeffrey C. Hall, Michael Rosbash and Michael W. Young for their work on understanding the molecular mechanism underlying Circadian Rhythms. So let's understand why this field and their work deserved this honour.



The word circadian comes from 'circa' that means 'about' and 'diem' that stands for 'day'. So our body has an internal or endogenous clock that has an effect on several of our daily behaviour, which however, can be modified by external factors such as light or temperature These clocks are present in every cell and are responsible for periodicity in behaviours such as sleep / wake cycle and feeding pattern in animals, leaf movements in plants, hormone production and other biological activities. The nature of the clock was confirmed when experiments showed that plants kept in continuous darkness continued to show the rhythmic leaf movements and that animals were capable of maintaining their 24-hour cycle even in the absence of light cues. Anybody who has flown across the world through different time zones would remember their

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feeling of 'jet lag' and how it affects mainly sleep but other behaviours as well. Similarly 'shift workers' tend to have metabolic disorders. This is because of a disturbance in our body's circadian rhythm.

These three scientists, awarded the prize, were the first to identify a gene called *period* in fruit flies (*Drosophila*) which is responsible for this rhythmicity. Disruption of this gene changes the circadian clock of the flies. Their experiments showed that the *period* protein levels varied over a 24-hour period, accumulating at night and degrading during the day. Later other genes like '*timeless*' and '*double-time*' were identified and these were shown to regulate the levels of *period*.



Drosophila :The fly the scientists worked on deserves the prize too!

This early work helped identify similar mechanisms in other animals including mice and humans. Interestingly, the genes and proteins found in most animals are very similar to those first identified in flies. Besides determining the sleep-wake cycle, circadian rhythms influences hormone release, body temperature, metabolism and other functions, and irregular rhythms have been linked to various chronic health conditions, such as sleep disorders, obesity, diabetes, depression and bipolar disorder. So is there a way to set back a disrupted circadian clock? Scientists in Japan have synthesized new chemical molecules that can shorten the circadian rhythm. Will this help in resetting our circadian clock that might have got disturbed? Maybe!! It's a start and such synthetic chemicals will definitely help in better understanding and sometime also altering this important rhythm that governs all our behaviours.

#### Additional reading :

www.scientificamerican.com/article/medicine-nobel-prize-goes-to-circadian-rhythm-researchers1

https://en.wikipedia.org/wiki/Circadian\_rhythm

http://www.the-scientist.com/?articles.view/articleNo/50544/ title/Giants-of-Circadian-Biology-Win-Nobel-Prize

www.sciencedaily.com/releases/2016/05/160529175837.htm



#### **Rational and irrational**

Prof. Vidyanand Nanjundiah, Centre for Human Genetics, Bangalore (vidyan@alumni.iisc.ac.in)

"Rational" means reasonable or logical. Some Indian languages use the same root, *tarka*, for rationality and logic. The chief difference between us and other animals is said to be that we are capable of rational behaviour, while they are not. We speak or act only after convincing ourselves that the possible result is what can be expected on rational grounds. Is that true?

All plants, animals and microbes are the products of evolution over hundreds of millions of years. Evolution works in many ways. One of the most important of those ways is called natural selection. It was first explained by Darwin and Wallace about 150 years ago. According to natural selection, living creatures differ from each other. Also, some are more successful in leaving behind children than others. That is because even if they have arisen entirely by chance, some of the differences make them better adjusted to their surroundings than others.'Better adjusted' can mean better at many things: better at using the oxygen in air or water for breathing, or using food for building the body, or at running, or swimming, and so on. Basically, it means better at whatever is needed to be able to live long, have children and take care of them until they have children of their own. It also means behaving in ways that are not foolish. For example, a mouse that came across a snake and did not run away from it would be behaving foolishly. So would a bacterium that kept swimming in the same direction from where a toxic chemical was being released, a tree that flowered during the cold of winter or a bird that built a weak nest. In short, living creatures must behave in ways that we would call rational. Their behaviour should "make sense". In the long run, an ancestor that did not show rational behaviour would not leave behind descendants. Only those ancestors who behaved rationally left behind the descendants whom we see today. Eventually, it may happen that the descendants do not need to work out the consequences of what they do, before doing it. Even when they have brains, many of their powers of analysis come as ready-made products of evolution, i.e., as instincts.

Here is a puzzle. We human beings have the most sophisticated brain of any animal. To a large extent, the human brain has freed us from the confines of instinct. And yet those human beings who should be least expected to do so, exhibit spectacularly irrational behaviour. One example comes from the alumni association of the Indian Institute of Science: they recently announced a two-day workshop titled "astrology in 24 hours" (so they got their arithmetic wrong too). The Indian Space Research Organisation, which gets satellite models blessed in temples before a launch, provides another example. How are we to understand this?

Further reading: https://www.csicop.org/si/show/ an\_indian\_test\_of\_indian\_astrology

### **Science In Daily Life**

# Do trees have brains ? What does research say ?

Ms. Anuttama Kulkarni, Department of Life Sciences, Sophia College, Mumbai.

What is a brain? It's a soft squishy organ that needs constant protection of sturdy bones. Just like humans all other animals possess a brain that looks more or less similar to our brain. Most animals communicate with each other and move from one place to another. They take care of their family. Capabilities of brains of each animal is different and that's why there is variety in the tasks they can accomplish. We never wonder whether animals have brains or not, we know they have.

Our brain is made up of very special kind of cells called `neurons' that receive signals from environment. The complex organizational network of neurons, takes all decisions for body, respond to the change in environment, learn and have a memory. Presence of this network is termed as 'Brain' in biology. Trees do not have any organ that looks like animal brain. Yet trees do take decisions, just like animals do. How do trees do this?

The most important decision in life of a plant is where and when to start sprouting. Seeds travel with wind, water or animal excreta and germinate only if they find an environment that supports them. Recent research shows that at the root end of seed there are two groups



of cells that decide whether the seed will germinate or not. These groups secrete hormones that say 'Go' if conditions are favorable. Hormones are a type of biochemical . In adverse environmental circumstances these groups of cells secrete signal hormones that say 'Stop'. These two groups of cells can be said to be the decision making organ- the brain - of the seed. It is only when both the groups send 'Go' signal by consensus, the seed starts germinating.

Trees, to some extent, can also learn from experiences. Researchers from Italy demonstrated this with help of a simple and easy experiment. Have you seen or heard of plant called 'touch me not'? True to its name, the plant contracts and closes its leaflets as soon as it suspects any danger or senses touch. The plant scientists made this plant fall on floor with help of a machine. While doing so, they took complete precaution as to not hurt the plant. They repeated this for 60 times. In the beginning, the shock of falling on floor makes Touch me not shrink and contract. But once the plant recognizes that the fall is completely safe, it changes its response permanently. The shock of falling down cannot force the plant to contract. Not anymore. How? What just happened? Touch me not just 'learnt' not to respond to false threat! Wow!

What changes take place at cellular and biochemical levels, as the plant 'learns'? Can other plants learn too? Do the plants remember incidences that took place? Till today, we do not have answers to such questions. But we know, for sure, that plants can execute some tasks similar to those carried out by our brain, and that they have a parallel arrangement for the same!

References :

1. Temperature variability is integrated by a spatially embedded decision-making center to break dormancy in Arabidopsis seeds. Alexander T. Tophama, Rachel E. Taylora, DaweiYanb, EijiNambarab, Iain G. Johnstona, and George W. Bassela. June 5, 2017, doi: 10.1073/pnas.1704745114. vol. 114 no. 25 6629-6634

2. https://www.monicagagliano.com/

#### Through the lens



Look out for this beauty around your home and school. Can you find out its name and identify the plant it is with ?

> **Stimulate Your Grey** A Tough One here !

> > Cyrus Khan,

#### Freelance Science Communicator

There are 2 identical empty jars. Along side the jars there are 50 red & 50 blue marbles. You need to put all the marbles into both of the jars in such a way that you have the **highest chance** of closing your eyes, putting your hand into any one jar at random and picking a red marble.

Hint: The number of marbles in each jar do not have to be equal.

## Long, Long Ago Zero Upon a Time

Ms. Simi Cyriac, St. Xaviers College, Mumbai.

When we were first taught "Mathematics", we started by learning 1, 2, 3... These are known as the natural numbers because we can associate them with things we see in the nature, for e.g., 1 sky, 2 eyes, 3 trees, and so on. Many of the earliest civilizations were familiar with these numbers. But the concept and acceptance of 0 as a number took a long time. Ancient Romans symbolized 5 as V and 50 as L but they didn't have a symbol for zero. Same was true with many other civilizations.

Historically, zero as a number was first used by mathematician Brahmagupta somewhere in 7<sup>th</sup> century A.D. His book Brahmasphutasiddhanta is the first literary work to introduce zero as a number. In this book, zero is used to symbolize "nothingness". Brahmagupta, in his book, gave arithmetic rules regarding 0, like, adding 0 to any positive number gives back the same number.

In 12<sup>th</sup> century A.D. mathematician, Bhaskaracharya, in his book Leelavati, extended the work of Brahmagupta by giving more properties involving zero. One of the most interesting properties he gave is division by zero. If n is a non-zero number, then what is  $n\div 0$ ? In other words, what will happen if a number is divided by nothing? Bhaskaracharya gave the answer as infinity. Even more bizarre is  $0\div 0$ . If  $0\div 0 = c$ , then  $c\times 0 = 0$  which is true for any number c. (Here we consider the usual relation between multiplication and division viz., if  $a\div b=c$  then  $b\times c=a$ )  $0\div 0$  is, therefore, known as an indeterminate number.

An interesting fact about the symbol used for zero. One theory is that 0 comes from the hole left behind on the soil when a pebble is picked up. (Pebbles were used in ancient times for counting).

It took a long time for people to accept 0 as a number but today we can't imagine a world without 0. It's used from computers to space travels and even the score we want our rival cricket team to get; zero has indeed come a long way.

## **Student Speak**

This feature is for students response... but this time it is with a special message from the editors. This is the fourth issue of Spectrum, we have sent you an issue every three months – that makes Spectrum one year old. And perhaps it is time to grow up a bit. So the new year will start with a breath of fresh air, with new team and new writers to take Spectrum to a different format.

All of you young readers have been our inspiration to bring out this small newsletter. Your formal and informal responses have encouraged us to make some exciting changes in the Spectrum... so do look out for the new form of the Spectrum in 2018

Answers to Quiz : Stimulate Your Grey, September 2017

1) C) East, because of Newton's first law of motion.

2) B) Both together, because the force in the downward direction (gravity) is the same for both of them.

3) C) East of Mumbai, because the Earth is rotating under them as they fly.

4) B) Deflated, because there is more pressure under water.

- 5) B) Venus
- 6) C) Stone, because it is the densest
- 7) D) Infrared waves
- 8)D) One twenty five times

#### Editorial Committee

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