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SCRIBE

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Sophia College (Autonomous)

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CONTENTS

ECO-CONCERN

QUICK READS (MINI REVIEWS)

SCI- FUN (CROSSWORD PUZZLES)

FROM THE STUDENTS DESK

Editorial

It gives us immense pleasure to bring to you the inaugural issue of **SCRIBE – Science Chronicles in Research and Investigation Based Education**, our own Science Journal at Sophia College (Autonomous), Mumbai, under the aegis of the DBT Star College scheme. We are extremely grateful to Dr. (Sr.) Ananda Amritmahal, Principal, Sophia College (Autonomous), Mumbai, for her kind support in this new and exciting venture.

Abounding curiosity coupled with focused research/investigation is the crux of good science. In fact, documenting scientific literature and all scientific evidence in the form of records or chronicles is also its inherent feature. This journal aims to encourage undergraduate as well as postgraduate students to nurture this curiosity and inculcate the necessary skills for scientific writing. It is our endeavour to offer a platform to share scientific thoughts, ideas and experiments and to instil and encourage the culture of science based on unbiased enquiry and systematic documentation. Along with the joy of knowledge dissemination, we hope that this journal may be a stepping stone for students to adopt a scientific temper. Our goal is to broaden students' horizons and develop their interests in eclectic fields of science, therefore the interdisciplinary nature of this journal.

We are delighted to present the following features:
An '*Invited Article*' on Scientific Writing by a celebrated scientist who is also an alumnus of our College.

'*Brief Communication (Short Research Articles)*' provides an opportunity for students to showcase their own research talents and makes young and enthusiastic readers aware of the nuances encompassing even minor research projects.

'*Scientific Review Articles*' are meant to add to the possé of knowledge, summarizing vast resources for use in further research.

A section on '*Trending in Science*' will give readers a brief insight into new and updated scientific discoveries to keep up with current times.

Short writeups on '*Nobel Prize of the Year*' shed light on the recent Nobel Prize winners and their discoveries in science.

'*From Indian Labs*' gives a flavour of research being carried out in a premier Institute in India and associated research workers in the field from other Institutes across the country.

Science, as with other fields of knowledge, stands on the shoulders of giants. So, it is only apt that we remember seminal contributions of better as well as lesser known prominent scientists. Towards this, a section on *'Did you know the History of Science'* has been included.

Books are a man's best friend, we have a section, *'From the Bookshelf'* which provides reviews on books that are related to science, even if remotely so.

There is a pressing need to make the society conscious and concerned of the growing threats to our environment which is why we have included a section on *'Eco – Concern'*.

'Quick Reads' are mini review articles providing a flavour of the topic at hand.

Often science is considered serious business, but certainly it's not without its moments of fun, so *'Sci–Fun'* are crossword puzzles. Also, some articles include *'Science cartoons'* to see science through a lighter vein.

'From the Students Desk' gives students a forum for expressing their creativity.

'Page of Fame' is in appreciation of our students who have cleared any competitive exam or who won any awards at Research Seminars/ Conferences at Inter-College/ State/ National/ International level during their studentship at Sophia College.

Excellence in Science Program (EXSP) was instituted in our College in 1991 with a vision of facilitating the overall development of highly motivated undergraduate science students in the form of scientific presentations (first year), scientific writing (second year) and a research project (third year). The category *'Beyond the curriculum: Excellence in Science Program: Third Year BSc Research Projects'* is a list of students who have successfully completed all three years of EXSP in this academic year.

Finally, a list of talented undergraduate and postgraduate students who have represented our College at Intercollege/ National/ International Science Research Meetings is provided.

Just like the beautiful oasis of nature brings a smile to anyone who steps into our campus, we hope *'Biodiversity@Sophia'* brings a smile to the reader's face. These are pictures of flowers and butterflies taken by our students on campus.

Overall, we hope this effort promotes scientific thought and reveals the joy of 'doing' science!

Bhavna Daswani & Hema Subramaniam

INVITED ARTICLE

Scientific Writing: Getting Started

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Dr. Nafisa H Balasinor is an alumnus of Sophia College and a celebrated scientist in her field of work. Her research interests include epigenetics & reproductive neuro-endocrinology.

Communication is one of the most essential characteristics of all living beings. Humans developed a unique communication skill, that is 'writing.' Writing is a way of documenting and communicating one's ideas and facts to others.

As mentioned by Karen Worth, "*Writing in science is not only for communicating with others; it is also a tool for learning that supports scientists and students alike in clarifying thinking, synthesizing ideas, and coming to conclusions*. "There are different forms of scientific writing, ranging from laboratory notebooks, project reports, papers in academic journal, articles in science magazines to chapters in books.

It is through writing that ideas and facts gathered through ages are available to future generations. In science, writing also leads to making one's research finding available to others so that the research outcome can be used for the benefit of the mankind and improvement in quality of life. Additionally, it helps the scientists to voice their ideas and get credit for their work.

The main goal of scientific writing is to communicate scientific information clearly and concisely, thus, it is important that the writing is accurate and simple. Flowery, vague and ambiguous language should be avoided. It is essential that statements are supported by appropriate evidence on which the conclusion or inference is based. At the same time, the researchers whose studies are being cited must be acknowledged. It is beneficial to readers if the writing is structured properly as, it makes it easy for them to understand the content.

Usually, most of the scientific papers or reports follow a standard pattern known as IMRAD (Introduction, Materials & Methods, Results and Discussion). 'Introduction 'places the study in the context of previous research, addresses the gap in the current knowledge and ends with the rationale of why the study was done. All the materials used for the research, the

methods and the experimental protocols are described in 'Material and Methods.' The detailed results obtained from the experiments carried out are mentioned in 'Results' section. It is important to know how the results are to be presented, that is, whether they should be in textual form, figure, graph or table. This depends on what is the easiest way for the reader to understand them. In 'Discussion,' the results obtained in the study are discussed with the available evidence in literature and finally a conclusion is drawn based on the results and previous research.

The writing could be published in different forms, such as, in a specific journal or in a science magazine that is available to the public at large. It is essential for researchers to publish scientific research articles in indexed journals. Indexation of a journal reflects its quality. Indexing basically involves a list or a database of journals created by a particular agency or organization which selects journals after checking various parameters, according to their rules and regulations. Some of the most popular journal indexing agencies where one can check whether the journal is indexed are International Scientific Indexing (ISI), Thomson Reuters, Google Scholar, Scopus, PubMed and Index Copernicus. The indexing of any journal helps to have larger visibility to the other researchers and users.

To conclude, budding research scholars need to hone their writing skills so as to have a widespread outreach of their research findings not only to fellow scientists working in similar areas but also to, administrators, who can utilise them for the welfare of mankind.

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Estimation of Amylose in Different Varieties of Rice Samples

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Abstract:

Rice is one of the most important cereals which is essential food for Indian population. Amylose and amylopectin are supplied from glucose units. The amylopectin gives a reddish brown colour complex with iodine whereas amylose gives a blue colour complex. The amount of amylose content is considered as the main parameter of cooking and eating quality. Amylose in the rice samples was estimated as its iodine complex spectrophotometrically at 620 nm. In the present study HMT Kolam rice showed highest amylose content (9.34%) and Chacha Chaudhary Basmati rice was found to have 6.33% of amylose.

Keywords: Rice, Amylose.

Introduction:

Rice is the seed of grass species that belongs to the genus Oryza, of which *Oryza sativa* is the most commonly grown species. It is an important staple food consisting majorly carbohydrate. Carbohydrate is one of the biopolymers that contains number of glucose units (Buléon *et al.,* 1998). The combination of glucose units consists of two main structures as amylose and amylopectin (Knutson, 1986). The ratio of amylose and amylopectin are the important factor to indicate quality of starch (Banks *et al.,* 1974; McCready *et al.,* Knutson and Grove, 1943; Rao *et al.*, 1952; Dipti *et al.*, 2002).).

Amylose is a linear structure whereas amylopectin is branched structure. Rice with a high amylose content tends to cook firm and dry and rice with a low amylose content (less than 6%) is soft and sticky (Wuttisela, 2008; Asghar *et al.*,2012). For a type II diabetes patient the sugar level spikes just after a meal due to lack of insulin. The glycemic index is the release of glucose in the blood by the breakdown of carbohydrates. Glycemic index and amylose content are the two properties which can be taken into consideration and they are inversely proportional to each other. Thus a high amylose content showing a low glycemic value is suitable for type II diabetes patients (Jeevetha *et al.,* 2014).

Lipid is one of natural interference in amylose determination. It binds with amylose structure in nature that competes with iodine to form complex. It should be eliminated from sample before analyzing. Elimination of lipid can be done by different types of solvents such as methanol, ethanol, etc.

Method and Materials:

Chemicals: The chemicals and the reagents Starch, Ethanol, Sodium hydroxide, Acetic acid, Potassium iodide and Iodine were procured from the S.D fine – chemicals. All the solvents were of analytical grade.

Sample collection: The present research was done on six varieties of rice samples collected from a local grocery shop in Mumbai market, named Bhatner Kila rice, Patiala House Basmati rice, Chacha Chaudhary Basmati rice, Golden Basmati Sella Rice, HMT Kolam Rice, Keshav Basmati rice.

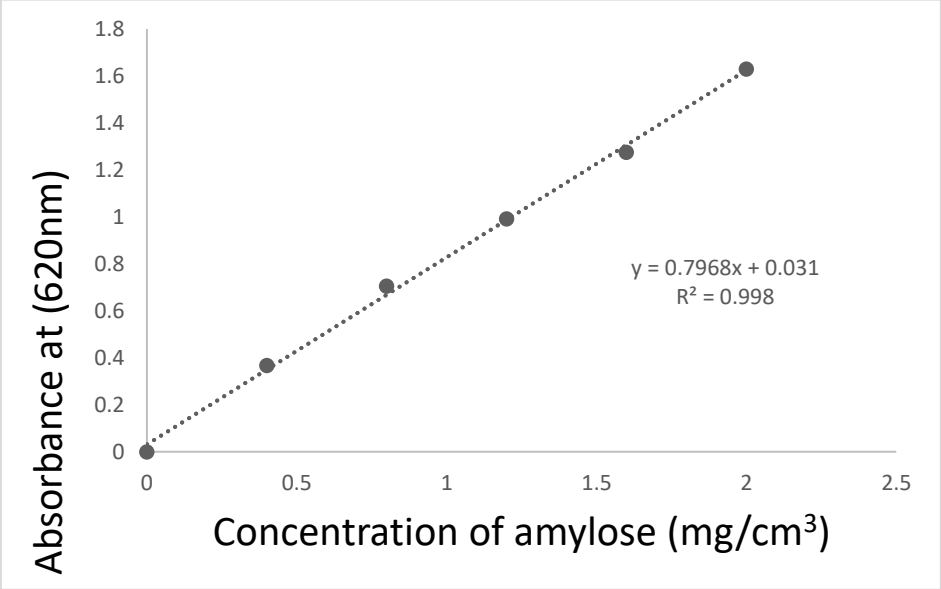
Preparation of standard solution: 40 mg of the potato starch was taken and dissolved in 1 cm^3 of ethyl alcohol and 9cm^3 of 1 N sodium hydroxide. This was then heated for 10 min in boiling water bath, cooled and made up to 100 cm^3. 1, 2, 3, 4 and 5 cm^3 of standard solution was transferred into 100 cm^3 volumetric flask. Followed by addition of 0.2, 0.4, 0.6, 0.8, 1.0 cm^3 of acetic acid and 2 cm^3 of iodine solution was added in the respective volumetric flask and the volume was adjusted to 100 cm^3 using deionized water. Absorbance at 620nm was measured.

Treatment of rice sample: The analysis of blue amylose iodine complex of rice sample was adapted from a previous study *(Juliano, 1971).* Whole grain rice is ground to pass through a mesh. A 100 mg of milled rice sample was weighed and suspended in 1 cm^3 of 95% ethanol and 9 cm^3 of 1 N sodium hydroxide. Sample was heated for 10 min in a boiling water bath to gelatinize the starch, cooled and transferred with several washings with deionized water then the volume of sample was adjusted to 100 cm^3.
10 cm^3 of the above solution was put into a 100 cm^3 volumetric flask and 2.0 cm^3 of 1N Acetic acid and 2 cm^3 of 0.2% iodine reagent was added. The solution is made up to the mark with water and allowed to stand for 20min. This leads to the development of blue amylose iodine complex. 0.2% iodine reagent was prepared by dissolving 0.2 g of iodine and 2.0 g of potassium iodide in 100 cm^3 of deionized water (Knutson & Grove, 1994). Absorbance at 620nm was measured.

Results:

The HMT Kolam Rice showed the highest amylose content 0.95 ± 0.0808. While the lowest was seen in Golden Basmati Sella Rice that is 0.63 ± 0.0568.

Fig 1: Standard calibration curve.



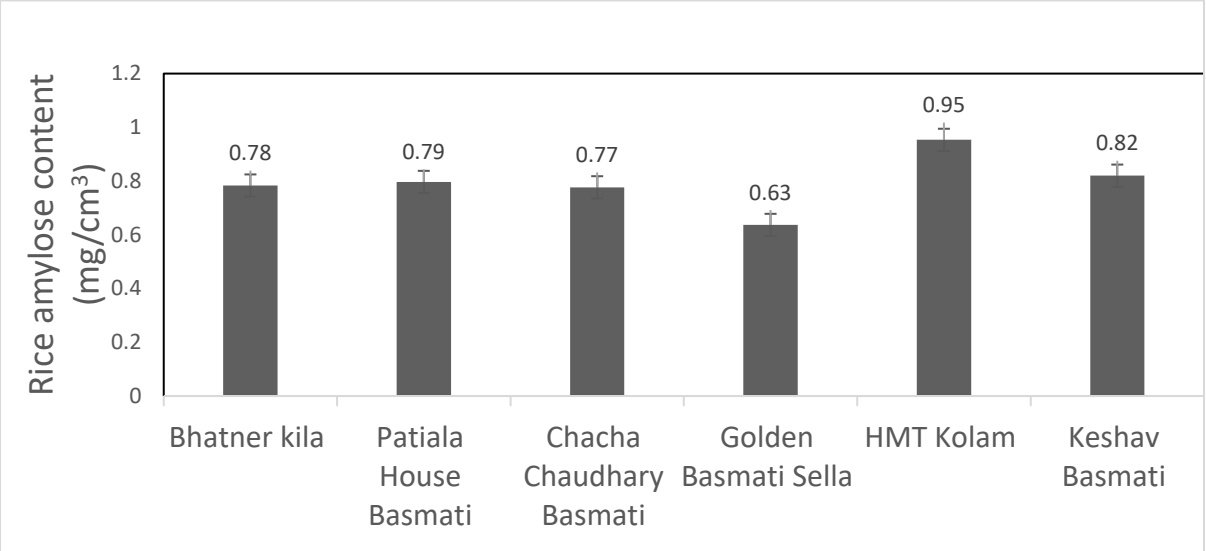
The data expressed as mean value ± SD (n=3). All values are significant $p<0.05$.

Table 1: The total amylose content (mg/cm^3) in various rice samples.

Name of rice sample	Amylose content (in mg/cm^3)
Bhatner Kila rice	0.78 ± 0.0404
Patiala House Basmati rice	0.79 ± 0.0472
Chacha Chaudhary Basmati rice	0.77 ± 0.0251
Golden Basmati Sella Rice	0.63 ± 0.0568
HMT Kolam Rice	0.95 ± 0.0808
Keshav Basmati rice	0.82 ± 0.0400

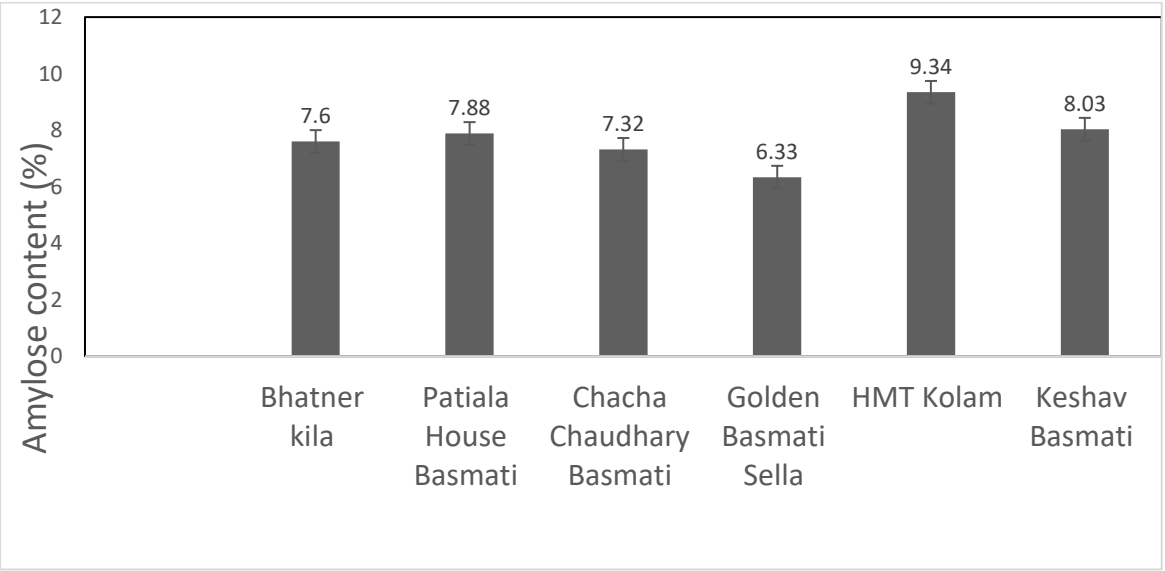
The data expressed as mean value ±SD (n=3).

Fig 2: Comparison of amylose concentration in different rice samples (mg/cm³).



The data expressed as mean value ± SD (n=3).

Fig 3: Comparison of amylose concentration in different rice samples (in %).



The data expressed as mean value ± SD (n=3).

Discussion:

Amylose content of the tested varieties ranged from 6.00-10.00%. The highest amylose content of 9.34% was observed in the HMT Kolam Rice followed by Keshav Basmati Rice 8.03% and the lowest was found in Golden Basmati Sella Rice 6.33 % (Fig 3). HMT Kolam Rice showed a comparably highest percent of amylose. High percent of amylose indicates the rice is non sticky, dry and has a low glycemic index. Hence can be consumed by type II diabetes patients. The Keshav Basmati and the Patiala House Basmati got fairly higher

amylose content compared to the other brands of Basmati rice. The Golden Basmati Sella Rice having low amount of amylose indicates high glycemic index.

Conclusion:

The result indicates that the amylose content can be measured in different varieties of rice samples by iodine – complexation spectrophotometrically. Rice was collected from a local grocery store thus the results obtained through this research tells us greatly about the health impact people would face and the selection priority for the quality of rice over one another. Rice having amylose content greater is more advantageous over the others.

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Estimation of The Total Polyphenolic Content in Different Brands of Herbal Shampoos

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Department of Chemistry

Abstract:

The research deals with estimation of polyphenols in different brands of herbal shampoos. Polyphenols act as anti-oxidants and are present in most herbal shampoos. The formulated shampoo contained herbal extracts like amla which was the common plant extract. The total polyphenolic content was determined by three different spectrophotometric methods; Folin-Ciocalteu and Prussian Blue at absorbance values 550nm and 700nm respectively. Six brands of herbal shampoos were analysed for its polyphenolic content and Indulekha showed the highest percentage of polyphenols among all the shampoos analysed.
Keywords: Polyphenols, Polyphenols content, Herbal shampoos.

Introduction:

Herbal shampoos contain some amount of plant extracts that help in giving shine, nourishment and in providing a healthy look to the hair. Herbs were only used in food till it was found to be beneficial in cosmetic industry too. The word herbal comes with trust and a symbol of safety compared to the synthetic preparations that has adverse effects. In today's life there is a major negligence about hair health and so there is a need to go back to the traditional formulations which contain herbs to avoid hair damages rather having chemical shampoos containing high amount of paraben which is mostly used as a preservative (Al Badi and Khan, 2014; Patel and Talathi, 2016).).

Polyphenols constitute one of the widely distributed group of substances in the plant kingdom. More than 8000 structures of phenolic compounds are known currently. They can be further divided into 10 different classes. Depending upon their chemical structure and ranging from simple molecules, such as phenolic acids, to highly complex compounds, such as tannins (Manach *et al.,* 2004).

Phenolic compounds are a heterogenous group of substances that are majorly found widely in the plant kingdom. Tannins, anthocyans, phenolic acids, flavonols and stilbenes are some of the polyphenols present in plants. Polyphenols are beneficial plant compounds with antioxidant properties that helps in keeping one healthy and for protection against various diseases. They are micronutrients that we obtain through certain plant-based foods.

Materials and Methods:

Chemicals: The chemicals and reagents: - Gallic acid, Folin Ciocalteu reagent, Na_2CO_3, ethanol, $K_4Fe(CN)_6$, $FeCl_3$, were procured from S.D fine chemicals. All the solvents and reagents were of Analytical Grade. (González *et al.,* 2003)

Collection of samples: Six different brands of shampoos were used for this study. Ayush and Indulekha (HUL), Biotique Bio Ayurvedic (Biotique), Kartika (Cavin Kare), Himalaya herbal shampoo (Himalaya), Vatika (Dabur). The shampoo samples were collected from a local shop.

Folin Ciocalteu method: Folin-Ciocalteu colorimetric assay (FC) is the most common method to calculate the total phenolic content in foods, herbs and other plant extracts. Plant extracts containing polyphenols react with specific redox reagents (Folin-Ciocalteu reagent) to form a blue complex that is quantified by visible-light spectrophotometry at 550nm. This method is described in several pharmacopoeias. In this reaction, there is a formation of a blue chromophore in which it is constituted by a phosphotungstic-phosphomolybdenum complex, where the chromophores maximum absorption will depend on the alkaline solution and also on the concentration of phenolic compounds. The reaction provides accurate data for several groups of phenolic compounds (Berker *et al.,* 2010).
In this method, the total phenolic content was determined spectrophotometrically and 0.4% of Gallic acid was used as the standard. Different aliquots of gallic acid (0.125-1ml) were added to the flasks containing FC reagent. After 3 min, 10cm^3 of sodium carbonate was added and the total volume was made to 16cm^3. The absorbance was measured at 550nm against water as a blank. The total phenolic content was expressed in Gallic acid equivalents in mg as GAE of shampoo (Alhakmani *et al.,* 2013; González *et al.,* 2003; Ainsworth and Gillespie, 2007).

Prussian Blue method: Price and Butler proposed the method of the use of mixture of 0.0008M potassium ferricyanide and 0.1M ferric chloride in 0.1N HCl for the determination of total polyphenols in plant materials (Hagerman, 2002). These polyphenols react with the mixture, producing colour and the intensity of the colour depends on the concentration of polyphenols present in the sample. The reaction is carried out in presence of an excess of Fe^{3+} which acts as an oxidant. (Berker, 2010).
In this method, 0.4cm^3 of 0.0008M Potassium ferrocyanide and 0.1M Ferric chloride were added to the flasks along with gallic acid the total volume was made up to 10 cm^3. The absorbance was measured at 700nm against a reagent blank after 15 mins (Graham, 1992; González *et al.,* 2003).

Results:

Total phenolic content was estimated in different brands of herbal shampoo spectrophotometrically by Folin-Ciocalteu and Prussian Blue methods. The calibration curve by Folin-Cioalteu method at 550nm showed R^2 =0.958 (Fig.1) and Prussian Blue method at 700nm showed R^2=0.989. (Fig.2).
Folin-Ciocalteu method showed almost double the percentage of polyphenols in different herbal shampoos compared to Prussian Blue method (Table no.1 and 2).

Fig.1 Calibration Curve: - Folin-Ciocalteu Method.

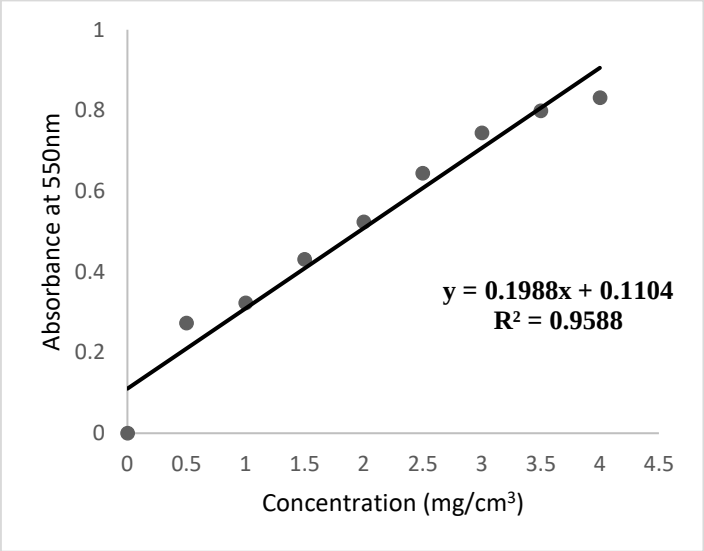


Fig.2 Calibration Curve:- Prussian Blue Method.

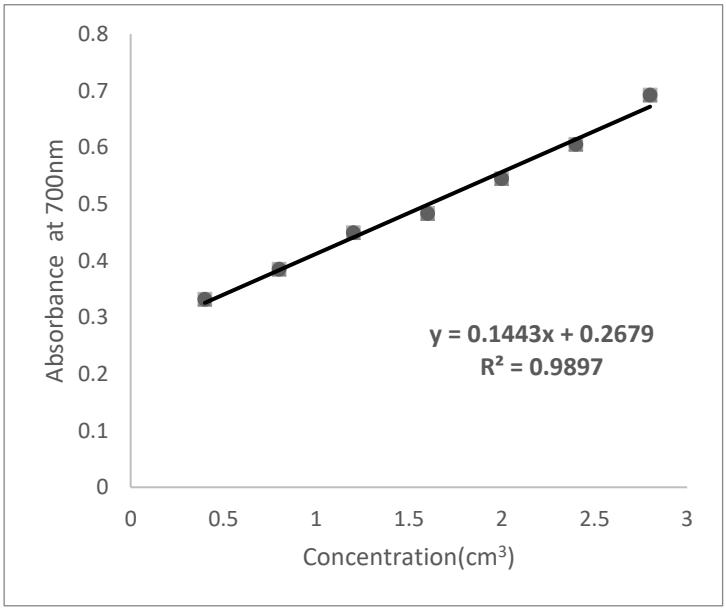
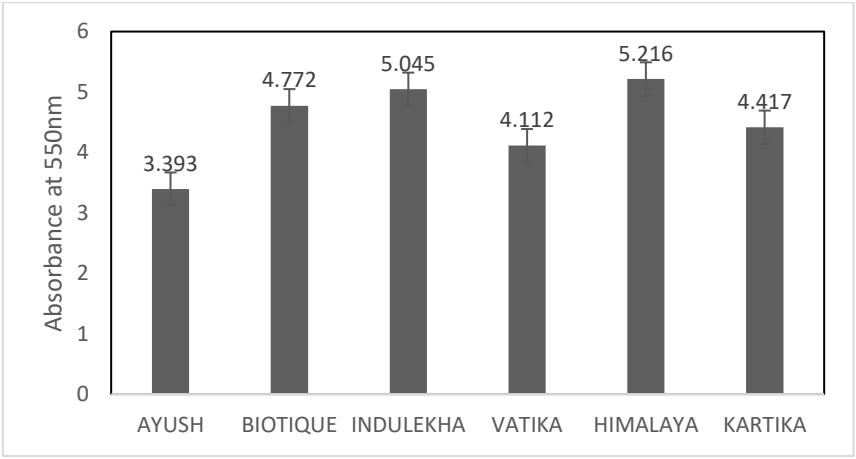


Table 1: Percentage of polyphenols in different herbal shampoos by Folin-Ciocalteu Method.

Samples	Folin-Ciocalteu method
Indulekha	5.04±0.060
Vatika	4.112±0.054
Ayush	3.39±0.234
Kartika	4.417±0.029
Himalaya	5.216±0.045
Biotique	4.77±0.03

Fig. 3 Graph of percentage of polyphenols in different herbal shampoos by Folin-Ciocalteu method.

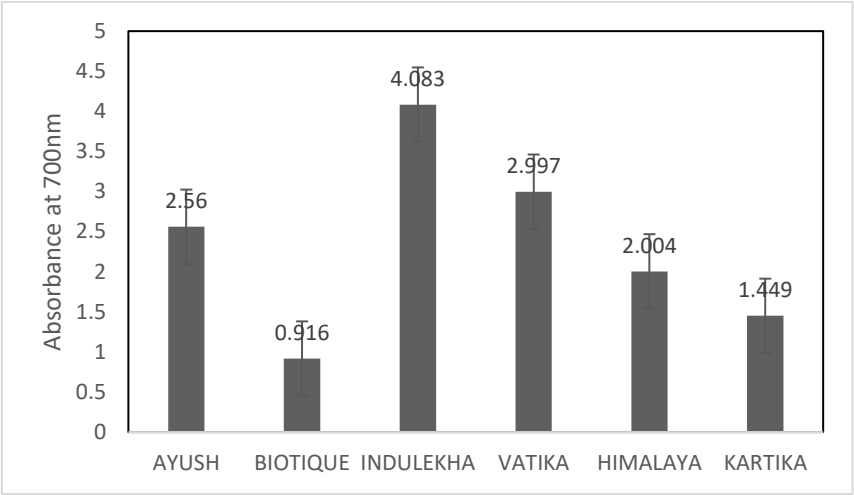


The data expressed as mean value ±SD (n=3).

Table 2 Percentage of polyphenols in different herbal shampoos by Prussian Blue Method.

Samples	Prussian Blue Method
Indulekha	4.08±0.221
Vatika	2.99±0.05
Ayush	2.56±0.137
Kartika	1.44±0.137
Himalaya	2.00±0.05
Biotique	0.901±0.05

Fig. 4 Graph of percentage of polyphenols in different herbal shampoos by Prussian Blue method.



The data expressed as mean value ±SD (n=3).

Discussion:

Himalaya was observed to have the highest and Ayush had the lowest percentage of polyphenols by Folin-Ciocalteu method whereas in Prussian Blue method the same trend was not observed. Indulekha showed the highest percentage and Biotique was observed to have the lowest percentage by Prussian Blue method whereas the observation in the former method was not the same.

Conclusion:

The results indicate the percentage of polyphenols in different herbal shampoos. The formulated herbal shampoo containing polyphenols is chemical free. The total polyphenolic content was also analysed. This study showed that most herbal shampoos contain some amount of herbal extracts. Indulekha showed the highest percentage among all the herbal shampoos that were analysed.

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Impact of Mobile Screen Time on Sleep Duration

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Introduction:

The Internet is a very convenient tool for purposes, such as electronic commerce, frequent and quick sharing of information, for maintaining contact with others, emotional support, and entertainment. Smartphones provide quantifiably different services in extension to the benefits that the Internet offers today. The young generation watches videos, communicates with friends and searches for information using smartphones, while older people may use their smartphone for having video calls and for playing games etc. The manoeuvrability and accessibility of a smartphone makes it possible to use it anywhere and for any time span.

Due to increased usage of smartphones by the current younger generation, several studies have been conducted on smartphone usage and its impression on adolescents. These studies and research have been conducted over the years using different human behaviour as dependent and independent variable. Over the years, researchers have examined adolescents' physical health or educational performance with smartphone addiction and some others have analysed psychological behaviour and social relationship with mobile phone addiction (reviewed in Cha & Seo, 2018).

Over the past decade, the decrease in the cost and increase in computational power of smartphones and mini computers, has brought about an enhancement in personal communications. The user base of mobile phones has increased exponentially since the start of this decade. It is estimated that there were 181.4 million smartphone users in 2013 alone, up from 115.1 million in 2012. Smartphones were used by 1.85 billion people worldwide in 2014. Which was expected to be 2.32 billion in 2017 and 2.87 billion in 2020 (Statista, 2017). Smartphones offer ease in our life, but there are numerous negative effects of smartphone use, the most concerning aspect being its addiction. Smartphone addiction is a phenomenon that pertains to tremendous usage of smartphones. People with this problem encounter social, physical, psychological, and health problems (Heron and Shapira, 2003). Hence studies have been designed to predict whether a habitual user can become addicted to the smartphone and whether factors like social stress, self-regulation, age and gender affect such behaviour (Van Deursen et al, 2015).

It was found that the melatonin levels were increased after sleep deprivation, whereas the cortisol levels remained the same. These results suggest a mechanism by which a reset of abnormal rhythms can occur in depression. (Salín-Pascual, et al. 1988.) Since insomnia can also be due to other medical disorders many others have reached a conclusion that it may not necessarily have negative impacts on sleep patterns. Excessive smartphone use at night could keep one awake till late, thus hindering sleep and inducing stress and depression (Lemola et al., 2015). Screen time and frequent use of the internet were found to affect sleep patterns on a daily basis, (Brunborg et al., 2011; Vollmer et al., 2012), also SNS (social networking site)addicts were reported to show poorer sleep quality than non-SNS addicts.(Wolniczak et al., 2013).

Study conducted in Norway on 9846 adolescents resulted in 90% of them using their mobile phone before going to bed. Another study among 844 Flemish adults who also used mobile phone before bedtime showed symptoms of fatigue, insomnia and poor sleep quality. It was thus concluded that, several risk factors arise due to short sleep duration which lead to overweight and obesity and appetite regulating hormone ghrelin showed elevated levels due to sleep restriction (Rod et al, 2018) .

Study in America concludes that the normal sleep range in adolescents varies from 8.5-10 hours per night. While it was observed that average of them receive only 7.5-8.5hours of sleep per night, while the others receive about 6.5 hours of sleep during school nights (Adams et al, 2013).

Due to these conflicting reports, in this study, we targeted teenagers and young adults aged 13 to 25 years, to examined the characteristics of their smartphone addiction and usage to their sleep duration.

Materials and Methods:

For carrying out the survey a group of individuals age ranged from 13 to 25 years old were selected. Systematic collection of accurate data was done by using a mobile application for recording screen time and manual recording of the sleep hours. The data collection for each individual was done for a week long period. All the participants were made to install the application **'My Phone Time'**. This application accurately collects the data for the mobile phone usage of the phone of the user by all the applications on the mobile phone.

Sleep hours were manually recorded for each individual for seven days continuously. To get further details of the daily routines, lifestyle and habits a questionnaire was distributed to the participants. Questions about their phone using habits, sleep timings, their study timings and related habits and lifestyle was asked. The questionnaire helped us to understand the overall routine of these individuals. The data so collected was analysed by using correlation and T-test. The result was drawn considering the correlation between sleep hours and mobile screen timings.

Results:

The data of 44 individuals was recorded for a week for their screen time and sleep time. In the data, the mean of an individual's screen time and sleep data was analysed using correlation analysis. Then the screen time of participants with sleep time less than and up to 6 hours was compared with those having a sleep time of more than 6 hours using T test. The p value of the performed T test is <0.01.

Figure1

Given below is a scattered graph of means of screen time (X axis) v/s sleep time (Y axis).

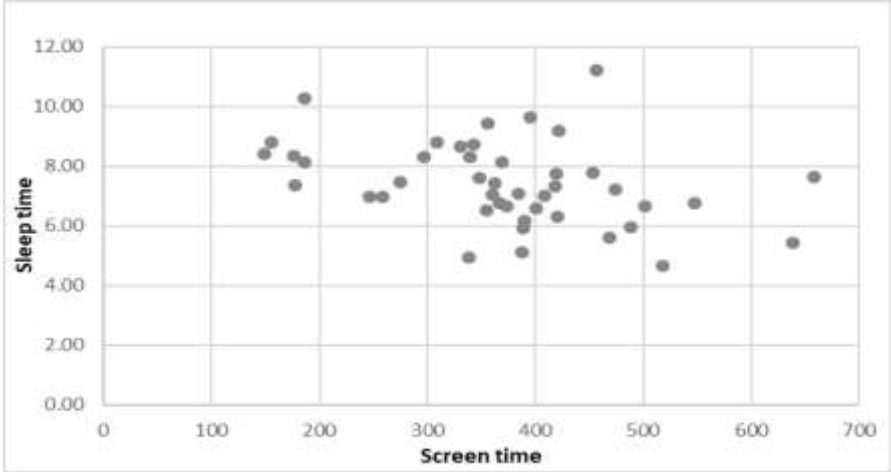

Figure 1 is a scatter plot of sleep time against screen time. Pearson's correlation analysis gave the correlation coefficient as **-0.37** suggesting a moderate negative correlation. The correlation coefficient values vary from -1(perfect negative correlation) to 1(perfect positive correlation). Similarly, after performing T-test it was observed that there was a significant difference between the screen time usage of persons having sleep time less than or greater than 6 hours. The questionnaire also gives us several other details about the participants, that about 59.65% of them received their mobile phones around 12 years age. 94.45% mobile phone users use their phone while going to bed. Approximately 30.45% mobile phone users' experiences stress, anxiety and depression very often and 30.35% of them experience it sometimes. 34.7%

of the participants go to bed between 1 am and 2 am at night and wake up early the next morning.

Discussion:

Our study indicates that increase of phone usage has a negative impact on an individual's lifestyle. Since the correlation is negative it portrays that using more phone would give an individual less sleep. After the analysis and studying the responses to the questionnaire properly we understand that people using mobile phone more than the specified time limit seem to experience a certain amount of stress and anxiety. If those hours spent on the phone are not constructive an individual is seen to have a disturbed lifestyle. Most of the participants showed irregular sleep cycle. Those who did not have a set timetable of sleep felt a certain amount of tiredness. We understand from our survey that people using the phone in excess would not realise the amount of time spent on their phone and thus continue using it till late night sacrificing their sleep hours.

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Facets of Stem Cells and Cellular Reprograming in Regenerative Medicine

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Introduction:

Human beings have a limited capacity to regenerate cells and tissues. Disease and injury often result in degeneration and loss of cells with devastating consequences. Regenerative medicine aims at replenishing such cells which is a challenging yet possible task. While this has been a subject of basic and clinical interest for many decades, it has recently gained momentum due to the discovery of newer technologies. We now live in an era where scientists are able to grow a majority of cell types in their laboratories, the nerve cells, the heart cells, the liver cells, the pancreatic cells, almost any cell that you want! What was the journey like to reach this era and what are the current technologies that prevail in this era? We review here the early discoveries of totipotency, embryonic, adult and induced pluripotent stem cells, followed by 'transdifferentiation', while also touching upon possibilities and challenges with respect to regenerative medicine.
To begin with, let us recall some basic terminology. The ability of a cell to acquire its functional state during embryo formation is broadly called 'differentiation' and its ability to form the various cell types defines its 'potency'. A fertilised egg can be considered a totipotent stem cell as it has the capacity to form any cell type of the body. As lineage restriction sets in, embryonic stem cells (known as pluripotent stem cells) are formed in the embryo and they give rise to adult stem cells (known as multipotent stem cells) that are retained throughout adult life.

Adult cells retain their totipotency: A breakthrough of the last century
Until the beginning of the last century it was thought that as the cell loses its potency when travelling from a totipotent state to a terminally differentiated state, and the nucleus undergoes irreversible changes in a unidirectional manner such that it cannot revert back. Some scientists challenged this idea and argued that the nucleus of a specialized cell retains its totipotency, but in a dormant state; if put in the right environment, the nucleus of a specialized cell can help the development of an entire organism. In 1950s, Briggs and King transplanted a nucleus from a frog embryo in blastula stage of development into a fertilised egg whose own nucleus had been removed (Briggs and King, 1952). Interestingly, these transplanted eggs developed into tadpoles. However, their results were inconclusive, and critics argued that unceasing nuclear totipotency would be accepted only if the donor nucleus was from a specialized or somatic cell. In 1960s, John B. Gurdon used the nucleus from a specialized cell (skin cells) of a frog and transplanted it into an enucleated egg and to his

amazement embryonic development continued normally and the tadpole stage was reached (Gurdon, 1962). These experiments gave the first proof that differentiated adult cells retained their potency and could be manipulated for regeneration. This was also the basic premise for the famous cloning experiment 'Dolly the sheep' in 1996.

Embryonic/Adult stem cells: possibilities and challenges

Just as investigations were carried out in adult cells, studies were also being carried out on embryonic stem (ES) cells in the 1950s. An example of ES cells studied extensively were mice teratomas which had characteristics similar to cells in the blastocyst. This fascinated scientists as it was soon realized that ES cells can be used to introduce germline changes for studying developmental biology and/or used as a source for differentiation of nearly all cell types towards a therapeutic end. In 1981, scientists created the first *in vitro* 'mouse' ES cell line and this was followed by introduction of germline mutations into mice and the first knock-out mice were created (Downing and Battey, 2004). (Evans, Capecchi and Smithies were awarded the 2007 Nobel Prize in Physiology or Medicine for their work on ES cells). Subsequently, in 1998, Thompson and colleagues made the first in vitro 'human' ES cell line (Thomson *et al.*,1998). This was accomplished using left-over embryos from *in vitro* fertilization procedures. The development of a human ES cell line was definitely a boost to the stem cell community as it provided an abundant supply of human ES cells. However, it was realized that ES cells posed several technical challenges from a therapeutic perspective. Firstly, they were loaded with ethical issues, secondly, they carried a risk for rejection of the donor's cells by the recipient's immune system, and thirdly, they posed an inexcusable danger of spontaneous tumor formation, making them unsuitable for therapeutic use in regenerative medicine.

Some of these issues could be circumvented with 'adult stem cells. For example, bone marrow stem cells are adult stem cells that give rise to various blood cell types throughout life and these are the most abundant adult stem cells. In fact, bone marrow transplant is a common procedure in case of disease, injury or depletion of bone marrow stem cells due to chemotherapy. We also have tiny amounts of other multipotent 'tissue specific adult stem cells' in virtually every organ of our body; for example, neural stem cells in the brain, cardiac stem cells in the heart, satellite cells in skeletal muscle so on and so forth. However, these are extremely few in number and very difficult to isolate (Spangrude, 2003). They reside in our tissues in a quiescent (dormant) state and are activated for wound healing in case of tissue injury or disease (Spangrude, 2003). Owing to their presence one would assume that they can help us regenerate an entire organ *in vivo*, but this is not true simply because wound healing and regeneration are different phenomena with varying mechanisms, and unfortunately, we humans possess very limited regenerative capacity (unlike hydra or salamander).

Induced pluripotent stem cells: possibilities and challenges

To overcome the issues with ES cells, many researchers were trying to perform *in vitro* reprogramming of adult cells to regain their stem cell like properties which meant that a patient's own adult cells (say skin cells) could be taken and reprogrammed so that they can then be re-differentiated into a different adult cell type. In 2006, Yamanaka and colleagues succeeded in doing so using a magic cocktail of molecules called transcription factors (Takahashi and Yamanaka, 2006). As reprogramming surely involves molecular manipulation at the genomic level, of all the molecules that modulate gene expression transcription factors are known to be the ultimate players interacting with the DNA molecule. Yamanaka and colleagues took mouse fibroblast cells and forced them to increase the expression of four key genes by adding their respective transcription factors Oct4, Sox2, Klf4 and Myc(Takahashi and Yamanaka, 2006). The expression of these genes is usually lost somewhere along development and their re-introduction takes the cells back into their origins i.e. reversing the cell's potency. And voila, they reverted or de-differentiated into their pluripotent state just like embryonic stem cells! These factors came to be known as 'Yamanaka factors' and he called these cells 'induced pluripotent stem cells' or iPSCs. Once pluripotent, they now had the ability to be transformed into any cell type of the body using different cocktail of chemicals. It was brilliant because this meant that skin cells could be taken from a Parkinson's patient and turned into an undifferentiated or pluripotent state which could then be coaxed into becoming dopaminergic neurons and put back into that patient. In 2007, he demonstrated the same results using human fibroblast cells (Takahashi *et al*., 2007). (Shinya Yamanaka and John B Gurdon shared the 2012 Nobel Prize in Physiology and Medicine for their respective work). Though free from ethical issues and immune-rejection, it was soon discovered that iPSCs have a few challenges. Since reverting to the pluripotent state is not an easy task, iPSCs are technically challenging, time consuming and expensive to make (Doss and Sachinidis, 2019). Moreover, the risk of spontaneous tumor formation as seen in ES cells persists even with iPSCs as they both share similar characteristics (Doss and Sachinidis, 2019). Although not free from its challenges, the use of iPSCs still holds a promise in regenerative medicine and extensive research is being conducted to overcome these challenges.

Transdifferentiation in regenerative medicine: possibilities and challenges

Scientists began to speculate that there had to be another way to transform one cell type into another. Then came a rediscovery - 'transdifferentiation'! The phenomenon of transdifferentiation has been known for several decades; however, its application in regenerative medicine has recently gained a global burst of enthusiasm (Merrell and Stanger, 2016). Transdifferentiation (TD) is simply a change of one mature cell type into another which sometimes occurs *in vivo* and is now being investigated *in vitro* for possible application in regenerative medicine (Shen et al., 2004). TD is a form of cellular plasticity which can

sometimes occurs naturally within a cell lineage (more common *in vivo*) or across cell lineages (less common *in vivo*).

The term 'transdifferentiation' was introduced by Selman and Kafatos in the 1970s. They observed that during 'metamorphosis' in the silk moth, cuticle producing cells transdifferentiate into salt secreting cells (Selman and Kafatos, 1974). It was also found that the surgical removal of the lens from the eye provokes the pigmented epithelial cells of the iris to transdifferentiate into lens fibre (Eguchi and Okada, 1973). These are only a couple of the many naturally occurring examples and while these are all during metamorphosis/development or due to injury/surgery, nobody thought that it was possible to actually transdifferentiate cells in the laboratory. In 1987, a landmark study by Davis and colleagues reported an *in vitro* experiment which resulted in the TD of fibroblasts into muscle cells (Davis *et al.,* 1987). Although this work didn't gain much attention when it was reported, it certainly laid the groundwork for future experiments in this area. It took a few decades for a surge of excitement wherein many researchers started delving deep into this subject. We now hear of *in vitro* conversions of lymphocytes into macrophages, fibroblasts into neurons or cardiomyocytes and many more. Even so, the entire range of conversions of different cell types is yet to be seen.

Remarkably, TD sometimes occurs inside us humans. While this is true, there are certainly fewer known examples of TD *in vivo* (whether human or any other animal) as compared to *in vitro*. The most famous example of human *in vivo* TD is between two types of pancreatic cells. On performing pancreatic ablation, the alpha cells in the pancreas (which secrete glucagon) can spontaneously become beta cells (which secrete insulin), the latter being an important functional entity of the pancreas (Zhou *et al*., 2008). Therefore, a major focus of diabetes research is on transdifferentiated beta cells from a therapeutic perspective. Intriguingly, it was also found that pancreatic cells can transdifferentiate into hepatocytes (liver cells) and this is probably due to the fact that they stem from common endodermal 'progenitor cells' during development (Hui *et al*., 2001). However, between the two organs, liver does have a limited regenerative capacity (called compensatory regeneration) which is not the case for pancreas. Hence, of late, researchers are exploring the possibility of converting hepatocytes into pancreatic beta cells (Shen *et al*., 2003). While this has brought a new ray of hope for diabetes; it still needs to be translated from bench to bedside. It should be noted that spontaneous transdifferentiation *in vivo* in adults (and not during embryo development) is usually caused of injury/disease and occurs between cell types that arise from a common lineage.

Mechanisms that govern TD: It is quite certain that any change in a cell's identity, whether it may be differentiation, de-differentiation or transdifferentiation, all involve 'change in gene expression'. This means a set of genes are activated and another set of genes are suppressed. During differentiation, genes related to cell proliferation are suppressed and genes related to differentiation and the new phenotype are activated. Often, a change in a master gene regulator (a gene whose protein product is a transcription factor that regulates other genes)

or a change in a couple of important transcription factors (that regulate the expression of important genes) is sufficient to cause a change in the cell's identity. Even though transcription factors are at the core of the process of TD, much emphasis has also been laid on epigenetics. A close cousin of genetics, epigenetics does not deal with alteration in the genetic sequence itself, but modification in the way genes are expressed leading to a different phenotype. These modifications majorly include 'DNA methylation/ de-methylation' and 'histone acetylation/de-acetylation' leading to chromatin remodelling. As a result, the chromatin of important genes may be loosened or tightened, thereby changing its possibility of being expressed. Further, these modifications are heritable or can be new, and can be triggered by the outside environment. In congruence, it has also been shown that changing the extracellular environment *in vitro* can trigger a series of changes that can lead to TD. Efforts to perform TD *in vitro* have been achieved either by a cocktail of transcription factors or by epigenetic modifiers (chemicals that inhibit DNA methylation/histone acetylation, hence, the chromatin structure and availability for transcription) or by using a combination of the two, with fibroblasts being the most popular starting material(Cho and Ryoo, 2018; Halley-Stott *et al*., 2013; Thowfeequ *et al*., 2007)

The term epigenetics was coined by Waddington in 1942 who also introduced the concept of 'epigenetic landscape'. This, he explained, was analogous to marbles rolling down a hill, our stem cells lose their stemness or potential and become more lineage restricted during differentiation (Kacser, 1957). Hence, de-differentiation into pluripotent stem cells and redifferentiation into a new cell type, as seen in iPSCs, involves rolling back up the hill before making another downward route. However, TD can occur directly without a complete de-differentiation saving time, energy and effort.

Although TD is direct reprogramming from one specialized cell to another, it does technically involve a step of transient de-differentiation; however, the level of de-differentiation may not be going back all the way to pluripotency. This 'so called' intermediate state does not last for long because no factors are provided to maintain this state. Hence, in the case of TD, there is a lower risk of spontaneous tumour formation which is a huge advantage for its application in regenerative medicine. However, major challenges with the use of TD still remain which is its time-consuming nature and reproducibility *in vitro*. Presently, our knowledge on TD is still in its infancy and a lot of effort needs to be steered towards it to tap its genuine potential. Also, with a current paradigm shift towards gene editing techniques, all these advanced technologies may be integrated in the future to revolutionize the world of regenerative medicine.

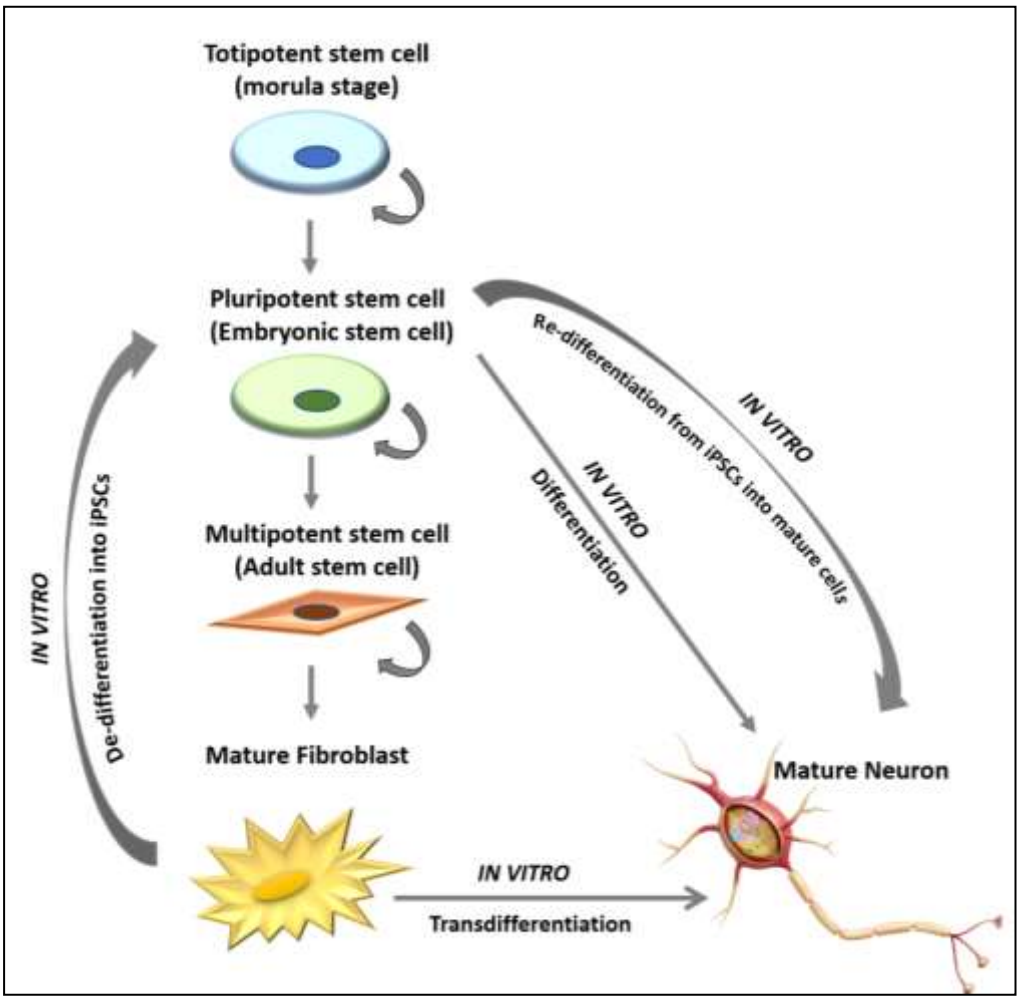

Figure 1: Routes for generating mature cells like neurons *in vitro* for the purpose of regenerative medicine - embryonic stem cells, induced pluripotent stem cells and transdifferentiation.

(i) The stem cell route includes the use of embryonic stem cells or pluripotent stem cells. The former can be directly differentiated into mature adult cells *in vitro*; whereas, in the case of the latter a different population of mature cells that are readily available have to be first de-differentiated into iPSCs (induced pluripotent stem cells) and then re-differentiated into the mature cells of interest. (ii) Transdifferentiation involves direct differentiation from one mature adult cell type into another.

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The world of RNA

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Introduction:

DNA molecules are very important biological molecules because they store the genetic information that is needed to produce the different types of proteins that are used by the cell. Thus, any type of damage or mutation in the DNA molecule would lead to disastrous consequences. Instead of continually using the DNA molecules to produce a protein, intermediate nucleic acids, known as RNA molecules are used. RNA molecule is essentially a copy of a segment of the DNA that has been transcribed. By using these intermediate RNA molecules, cells prevent damage to the DNA.
If you were to ask a Bachelor's student on how many types of RNA exist, they would probably reply saying three types- mRNA, tRNA and rRNA. If you asked the same question to a Master's student, would probably add a few more to the above mentioned three types, like siRNA, snRNA, etc.
But did you know that there are more than 25 types of RNA which play critical roles in cellular functions!

There are two major types of RNA:

(i) Coding RNA

The genetic code from the DNA is carried by the coding RNAs- messengerRNAs or mRNAs, in a form that is recognized to make proteins. After being transcribed from DNA, eukaryotic mRNA exists, for a brief period of time, in a form called "precursor mRNA (pre-mRNA)" before it is fully processed into mature mRNA. This step is called "RNA splicing", in which removal of introns, or the non-coding regions of the pre-mRNA takes place. The human genome encodes, approximately, 23,000 mRNA molecules. The coding regions in the mRNA are composed of codons, which are decoded and translated (in eukaryotes usually into one and in prokaryotes usually several) into proteins by the ribosome. Coding regions begin with the start codon and end with a stop codon. Generally, the start codon is an AUG triplet and the stop codon is UAA, UAG, or UGA. Some proportions of the coding regions may serve as regulatory sequences in the pre-mRNA; as exonic splicing enhancer regions or exonic splicing silencer regions.

(ii) Non- coding RNA (ncRNA)

ncRNAs are ribonucleic acids that do not undergo translation and thus do not give rise to production of protein molecules. After the transcription of DNA, these RNA molecules directly get involved in other vital functions of the cell, instead of undergoing translation. The length of ncRNAs can vary from 21 to several thousand nucleotides (nt) and these molecules are divided into i) long or large RNAs, such as transfer RNA, ribosomal RNA, and ii) small ncRNAs, such as microRNAs (miRNAs), small interfering RNAs (siRNAs), repeat associated small interfering RNAs (rasiRNAs), small nucleolar RNAs (snoRNAs), small nuclear RNAs (snRNAs), piwiinteracting RNAs (piRNAs) and others (Gavazzo *et al*., 2013). siRNAs are approximately 21nt in length and are produced from the processing of double-stranded RNA molecules by the enzyme Dicer. siRNAs are involved in gene regulation, as well as viral defense and transposon activity (Ghildiyal and Zamore, 2009; Malone and Hannon, 2009). rasiRNAs are approximately 24-27 nt long and play a role in heterochromatin orientation during the formation of centromeres (Theurkauf *et al*., 2006; Josse *et al*., 2007). snoRNAs consist of approximately 80 nt and are believed to be involved in the guidance of uridylation and/or site-specific methylation during ribosomal RNA maturation (Dieci *et al*., 2009; Taft *et al*., 2009); also, evidence suggests that snoRNAs can play a role in the regulation of gene expression (Matera *et al*., 2007). snRNAs have been shown to be part of the spliceosome complex (Peters and Robson, 2008; Tazi *et al*., 2009) and are important for removing introns from immature mRNAs (Valadkhan, 2005). piRNAs are approximately 26 to 30 nt in length, are restricted to germ line cells and function with AGO and PIWI proteins to regulate transposon activity and chromatin states (Ghildiyal and Zamore, 2009; Malone and Hannon, 2009). PiRNAs are also highly expressed in mammalian cells at the pachytene stage (Megosh *et al*., 2006).

The types of RNAs currently known are,

Circular RNA (circRNA)	Cis-natural antisense transcript (cis-NAT)	Enhancer RNA (eRNA)
Guide RNA (gRNA)	Long noncoding RNA (lncRNA)	Messenger RNA (mRNA)
MicroRNA (miRNA)	Parasitic RNA	Piwi-interacting RNA (piRNA)
Ribonuclease MRP (RNA component of mitochondrial RNA processing endoribonuclease; RNase MRP)	Ribonuclease P (RNase P)	Ribosomal RNA (rRNA)

Short hairpin RNA (shRNA)	Signal recognition particle RNA(7SLRNA or SRP RNA)	Small Cajal body-specific RNA (scaRNA)
Small interfering RNA (siRNA)	Small nuclear RNA (snRNA)	Small nucleolar RNA (snoRNA)
SmY RNA	Spliced leader RNA (SL RNA)	Telomerase RNA component (TERC)
Transfer RNA (tRNA)	Transfer-messenger RNA (tmRNA)	Vault RNA (vtRNA)
	Y RNA	

Detailed studies on all the above mentioned types of RNAs are ongoing. A short description of some of these, on which sufficient information as to their nature has been collected, are as follows (Table 1) -

Table 1. Types of RNA and their functions.

RNA Type	***Size (nucleotides)***	***Functions***
Messenger RNA (mRNA)	Up to ~100,000	Encodes proteins
Transfer RNA (tRNA)	~76-90	Transfers individual amino acids to the growing peptide chain during translation
Ribosomal RNA (rRNA)	Small subunit: 1,542 (prokaryote), 1,869 (eukaryote); Large subunit: 2,906 (prokaryote), 5,070 (eukaryote)	Responsible for Translation
MicroRNA (miRNA)	~22	Responsible for Gene regulation
Small interfering RNA (siRNA)	~20-25	Gene regulation
Piwi-interacting RNA (piRNA)	~26-31	Major function is Transposon defense
Small nuclear RNA (snRNA)	~150	Splicing and other functions

Description of a few of these types of RNA is,

1. mRNA

The operational definition of messenger RNA in mammalian cells came after the discovery of polyribosomes and the isolation from cells of polyribosomes containing labeled mRNA.This polysome-associated labeled mRNA had a low guanosine-cytosine content, like DNA, and was about 1500 nucleotides long (Darnell, 1977). The existence of mRNA was first suggested by Jacques Monod and François Jacob, and subsequently discovered by Jacob, Sydney Brenner and Matthew Meselson at the California Institute of Technology in 1961.

Messenger RNAs, or mRNAs, are synthesized in the nucleus and are carried to the cytoplasm by the ribonucleoprotein (RNP) particles. The mRNAs arise from the transcription of a specific region of DNA and are then carried to the cytoplasm via the RNPs and thus further undergo translation to produce specific proteins. The genetic sequence carried in the mRNA is in a sequence of nucleotides, arranged into codons consisting three nucleotides per codon. Each of these codons specify for particular amino acids except the stop codons which do not code for any amino acids.

Before the mRNA can be used by ribosomes as a template for building proteins, it must first be processed. The mRNA before processing is called the pre-mRNA. Key steps in the processing are the addition of a methylated cap and a polyadenylated tail. Involved in this processing are, RNA polymerase, cleavage factors and poly A polymerase. Processing of mRNA begins with transcription. Soon after RNA polymerase begins transcription, a methylated cap is added to the 5′ end. Transcription then continues to completion, followed by the release of cap strand on the mRNA by the RNA polymerase. Specific nucleotide sequences in the mRNA are bound by cleavage factors. The 3′ end of the mRNA is now moved to the correct configuration for the cleavage. Stabilizing factors are then added to the complex. This is followed by the binding of poly A polymerase to the mRNA, which cleaves the 3′ end.

The complex begins to dissociate and the 3′ end quickly degrades. Poly A polymerase now synthesizes a polyadenylated tail by adding adenine residues to the cleaved site. Additional proteins then bind to the tail, increasing the rate at which it grows. This process of poly A addition stops when the poly A polymerase dissociates from the 3′ end. The processed mRNA now undergoes splicing and is thus available for translation.

2. tRNA

The amino acids are added to the mRNA in the correct order by the tRNAs, or transfer RNAs. In the cell cytoplasm there are 60-70 types of different tRNAs (Donovan, 1982). The tRNAs are composed of 74-94 nucleotides. The tRNA secondary structure assumes the form of a clover leaf. An amino acid end and four loops can be distinguished in this structure. The amino acid arm is a spiral composed of several pair of nucleotides. A single stranded segment composed of three nucleotides, “CCA”, extends from this spiral. An appropriate amino acid

is attached to this via the means of a specialized enzyme to the free –OH group located at the end of this segment.

The first loop referred to as the D-loop, consists of 8-11 nucleotides. The second loop, i.e., the anticodon loop, is composed of seven nucleotides at the end of the stem made up of several pairs of bases. An anticodon is a group of three nucleotides located in the middle of the loop. Each amino acid that is to become a protein component is matched to a specific tRNA molecule bearing the appropriate anticodon. The third loop is variable and depends from one species to another and contains 3-18 nucleotides. The fourth loop is composed of seven nucleotides among which, there is a nucleotide with a modified base, marked with the symbol Ψ and thus the loop is called the TΨC loop.

3. rRNA

Ribosomal RNA, or, rRNA form a part of the protein synthesizing organelle known as the ribosome. The synthesis of rRNA occurs in a specialized region of the cell nucleus called the nucleolus, which appears as a dense area within the nucleus and contains the genes that encode rRNA. The encoded rRNAs differ in size, being distinguished as either large or small. Each ribosome contains at least one large rRNA and at least one small rRNA. In prokaryotes a small 30S ribosomal subunit contains the 16S ribosomal RNA. The large 50S ribosomal subunit contains two rRNA species (the 5S and 23S ribosomal RNAs). Eukaryotic ribosomes have two unequal subunits, designated small subunit (40S) and large subunit (60S) according to their sedimentation coefficients. Both subunits contain dozens of ribosomal proteins arranged on a scaffold composed of ribosomal RNA (rRNA). The small subunit monitors the complementarity between tRNA anticodon and mRNA, while the large subunit catalyzes peptide bond formation. Ribosomal proteins are synthesized in the cytoplasm and transported to the nucleus for subassembly in the nucleolus. The subunits are then returned to the cytoplasm for final assembly.

The rRNAs form extensive secondary structures and play an active role in recognizing conserved portions of mRNAs and tRNAs.

4. **miRNA**

MicroRNAs or miRNAs are a type of non-coding RNAs and are approximately 22-nt long, endogenously-initiated shortRNA molecules, that are considered to post-transcriptionally regulate the cleavage of target m-RNAs or just repress their translation. It is estimated that miRNAs constitute nearly 1% of all predicted genes in nematodes, flies and mammals (Lai *et al*., 2003).The significance of miRNAs had been long overlooked due to the limitation of technology and methodology until its initial discovery that two miRNAs, lin-4 and let-7, were found to control the timing of the nematode (*Caenorbabditis elegans*) development through incomplete base pairing to the 3'UTRs of the target mRNAs to repress their translation (Lee *et al*., 1993). Shortly after that, Reinhart et al detected the existence of miRNAs in *Arabidopsis* by Northern blot and the result suggests that this type of non-coding RNAs may arise early

in eukaryotic evolution. Thereafter, an increasing number of miRNAs have been successively identified through computational and experimental methods in animals, plants and even viruses.

The regulatory roles of miRNAs have been identified not only in developmental timing, cell differentiation, proliferation and apoptosis, but also in tumorigenesis and host-pathogen interactions (Liu, 2008).

These RNAs begin as primary RNAs or pri-RNAs and are usually transcribed by RNA polymerase II. The pri-miRNA transcript folds into a stem loop structure that generally has some unpaired nucleotides and single stranded extensions are found at both 3′ and 5′ ends. This structure serves the initial substrate for processing by 'Drosha", a nuclear RNAse-3 enzyme. Drosha interacts with a specialized binding protein called "DGCR8" in humans, to form what is termed, the microprocessor complex. This complex performs a cleavage reaction that removes the 5′ and 3′ extension and liberates a 60-70 nucleotide transcript known as the pre-miRNA. This pre-miRNA is thus recognized by a nuclear export factor called exportin-5, which transports the pre-miRNA to the cytoplasm for subsequent processing.

In the cytoplasm, a second endonucleotic cleavage reaction called dicing is catalyzed by dicer, another RNAse-3 enzyme. Dicer is found in a complex with a double stranded RNA binding protein called the tar RNA binding protein-2, or the, TRBP-2. The product of this second cleavage reaction is called the miR:miR* duplex. It carries 5′ monophosphates and 3′ overhangs of two nucleotides which is not fully complementary. The two strands of this duplex RNA are called the guide and passenger strands. This duplex is loaded onto the Argonaut protein which is dedicated to miRNA mediated silencing reaction. If the duplex is loaded in an appropriate orientation, one of the strand, miR guide strand is retained while miR* passenger strand is selectively removed. The guide strand will thus be involved in determining which RNAs would be silenced. Argonaut proteins charged with miR strands are referred to as the miRISC complex. The complex is thus ready to bind to its target RNA and promote gene silencing.

Once bound to targets, miRISCs recruit additional factors including a protein in particular, that contains multiple glycine and tryptophan repeats which is known as TRNC-6. This protein represses translation and destabilizes the mRNA.

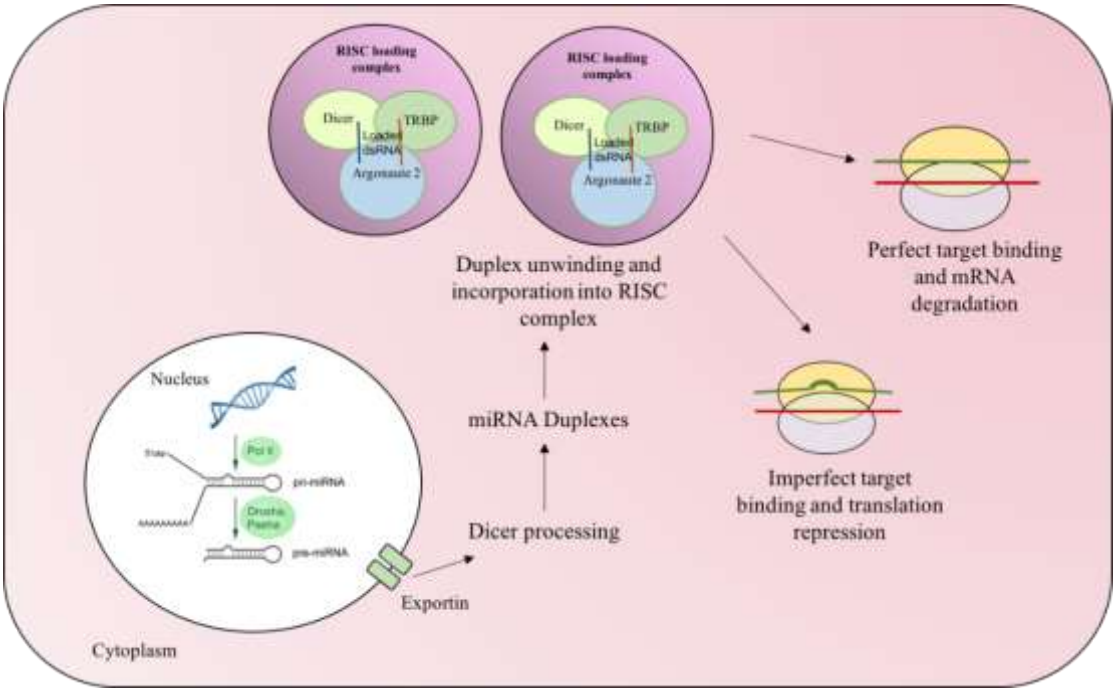

Fig. 1. miRNA processing

5. siRNA

One of the most important advances in biology has been the discovery that siRNA (small interfering RNA) is able to regulate the expression of genes, by a phenomenon known as RNAi (RNA interference) (Dana *et al*., 2017).

siRNAs, in contrary to miRNAs, are not encoded in the genome as specific genes. Instead, siRNAs are derived from double stranded RNA that comes from several different sources like, from the normal duplex RNA produced after transcription, or from the annealing of sense and anti-sense RNAs that have both been transcribed from a given locus, etc. Exogenous sources include viral RNA and synthetic RNA which are introduced into the cell. Irrespective of their sources, duplex RNAs become substrates for reactions akin to the processes of miRNAs but without the first nucleotide dependent Drasha cleavage. The cytoplasmic enzymes sequentially cleave the long duplex RNAs, approximately every 20-25 base pairs. The cutting frame is set by the interactions between the double stranded RNAs and the PAZ region of the dicer protein. The product of the dicer reactions are short duplex RNAs similar to the miR:miR* duplexes but fully base paired along the length. Once the siR:siR* duplex has been generated, it is loaded into the appropriate Argonaut protein while the siR* passenger strand is selectively removed. For these fully complementary siR:siR* duplexes, the endogenous endonuclease activity of the PIWI domain of the Argonaut protein catalyzes cleavage of the passenger strand. The cleaved strands are then easily unwound and released. This mechanism makes use of the RNA H fold of the PIWI region of the Argonaut protein. The resulting single stranded siRISC complexes can scan for their fully complementary target RNAs. The complete binding brings about conformational changes that activates the cleavage reactions, or slicing.

6. piRNA

Piwi interacting RNAs or the piRNAs, are involved in silencing transposable elements. Approximately 24-35 nt in length. These are transcribed by unidirectional or bidirectional active transposons or other repeats, found in piRNA clusters. These are bound to various piRNA proteins like, mili, miwi1, miwi2, etc. Single stranded precursors are transcribed from piRNA clusters. The primary processing involves the shortening of these RNAs followed by secondary processing which is known as the ping-pong amplification (Cernei *et al*., 2014). These processed piRNAs are then loaded on by various proteins like mili, miwi1 and miwi2. These piRNA-PIWI complexes allow degradation of transposon RNAs via dicers and Argonaut proteins. This thus aids in post-transcriptional silencing of the transposon RNAs.

7. snRNA

All eukaryotes possess a number of small nuclear RNA called the snRNAs, which measure 80-300 nt long and are rich in uridine. These are never translated but remain in the nucleus where they form a part of the spliceosome. In the human genome, there are many snRNA genes such as the genes for U1 which are concentrated on chromosome 1 in tandem arrays of genes with multiple copies in each array. Other snRNAs are concentrated on other chromosomes like U2 found on chromosome number 17. The snRNA U1 complexes with a number of proteins to form a SNRP (small nuclear ribonuclear protein) complex, which forms a part of the spliceosome. Thus, U1, U2, U4, U5 and U6 snRNAs each form a SNRP complex which in turn form a spliceosome which is responsible for the intron splicing during the RNA processing.

Evolutionary significance of RNA

History of origin of RNA

The origin of life on earth is one of the greatest questions humanity has ever posed. 120 million years ago was the year of dinosaur existence; 500 million years ago was the world of various sea creatures and 3.4 billion years ago was the world of the first living cells. If we were to go back further in time, scientists suspect that chains of a chemical called RNA or something similar to RNA gave origin to life.

RNA has thought to give rise to life for several reasons: (i) Chains of RNAs are found abundantly today in all living cells. (ii) RNA is a close relative of DNA, and (iii) From research it is proved that RNA chains can replicate, evolve and interact with their environments. This gave rise to the RNA world hypothesis, which states that, somewhere on the early planet, perhaps in a tide pool or a hot spring near the volcanoes, the Earth's chemistry was producing random chains of RNA. Once formed, they began replicating, evolving and competing with each other for survival. As these chains evolved and diversified, some chains eventually began co-operating to produce the genetic code, a wide array of complex proteins and even living cells.

The next stage in the emergence of an RNA World would have been the replication of some of these molecules, so that a process equivalent to natural selection could begin (Robertson *et al.*, 2012). It was seen that most activated nucleotides do not undergo efficient, regiospecific, template-directed reactions in the presence of an RNA or DNA template and only a small proportion of template molecules succeed in directing the synthesis of a complete complement, and the complement usually contains a mixture of 2′,5′- and 3′,5′-phosphodiester linkages. Working with guanosine 5′-phospho-2-methylimidazolide (2-MeImpG), it was shown that poly(C) can direct the synthesis of long oligo(G)s in a reaction that is highly efficient and highly regiospecific (Inoue and Orgel, 1981). If poly(C) is incubated with an equimolar mixture of the four 2-MeImpNs (N = G, A, C, or U), less than 1% of the product consists of noncomplementary nucleotides (Inoue and Orgel, 1982). Subsequent experiments suggested that this occurs preferentially within the context of double helices that have a structure resembling the A form of RNA (Kurz *et al.*, 1997, 1998; Kozlov *et al.*, 1999).

Abiotic Synthesis of Nucleotides

The origin of RNA and its synthesis can be explained using the flowchart (Fig. 2).

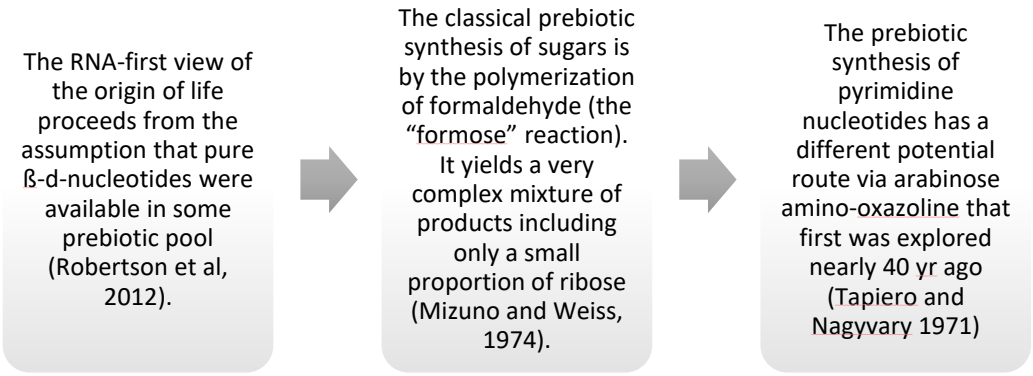

Fig. 2. History of synthesis of nucleotide

The earlier studies began with arabinose 3-phosphate, which, like arabinose and other sugars, reacts with cyanamide to give the corresponding amino-oxazoline which in turn reacts with cyanoacetylene to form a tricyclic intermediate that hydrolyzes to produce a mixture of cytosine arabinoside-3′-phosphate and cytosine 2′,3′-cyclic phosphate. However, the entire story remains incomplete because these synthesis reactions still prove to require temporally separated reactions using high concentrations and just the right reactants, and would be disrupted by the presence of other closely related compounds.

The reactions channel material toward the desired products, but other fractionation processes must be discovered that provide the correct starting materials at the requisite time and place. This "preprebiotic" chemistry would thus involve a series of reactions catalyzed by minerals or metal ions, coupled with a series of subtle fractionations of nucleotide-like materials based on adsorption on minerals, selective complex formation, crystallization, etc.

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Green Synthesis of Silver Nanoparticles with Different Fruit Juices: A Review

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Introduction:

The Nano dimensions (1 - 100 nm) show difference in properties compared to the same material in bulk. These differences lie in the physical and structural properties of atoms, molecules and bulk materials of the element due to difference in physiochemical properties and surface to volume ratio. With advancement in nanotechnology, a large number of nanomaterials are appearing with unique properties, opening a spectrum of applications and research opportunities (Sharma *et al*., 2009; Mody *et al*., 2010).
Nanotechnology is a field that is developing day by day, making an impact in all spheres of human life and encouraging a growing sense of excitement in the Life Sciences especially biomedical devices and biotechnology (Prabhu *et al*., 2010; Singh *et al,*. 2010). Several methods have been described for the synthesis of AgNPs, such as radiation, hybrid methods which are photochemical reduction and sono-electrochemical (Socol *et al*., 2002), chemical reduction (Iravani *et al*., 2014), micro-emulsions (Solanki and Murthy, 2010), microwave-based systems and recently there are green synthesis route (Nadagouda *et al*., 2011). Though some of the physiochemical methods are durable and technically viable but they are highly restricted in large-scale application due to the use of hazardous chemicals, high cost, high energy, time consumption and difficulty in waste purification (Kowshik *et al*., 2003). Hence, there is a growing need to use economical and environmentally safe routes that use non-toxic chemicals in the synthesis AgNPs. Alternatively, green synthesis route of AgNPs using several microorganisms, plants, and algae is natural, biocompatible and are environmentally safe methods (Bhattacharya and Gupta, 2005; Mohanpuria *et al*., 2008; Aziz *et al*., 2019). Metal-nanoparticles have marvellous applications in the area of catalysis, optoelectronics, diagnostic biological probes and display devices. Among the above four, AgNPs play a significant role in the field of biology and medicine (Leela and Vivekanandan., 2008).
Many researchers have worked on the green synthesis of AgNPs by using various fruit juices. In this paper, we have reviewed the synthesis of AgNPs with different fruit juices such as pomegranate (Punica granatum), grapes (Vitis vinifera), apple (Malus domestica), amala (Phyllanthus emblica), papaya (Carica papaya L.), orange (Citrus x sinensis), lemon and coconut (Cocos nucifera). The fruit juices are mixed with different concentration of $AgNO_3$ solutions and characterization of the silver nanoparticles formed are done using UV-VIS spectrophotometer, TEM, EDX, SEM, FTIR and XRD

1. Synthesis of AgNPs

Fresh fruits were taken from the local market and were washed with double distilled water. Approximately 20-25g were weighed and cut into small pieces and crushed (doubled distilled water was added in some amount). The juice of the fruits was filtered with Whatmann filter No. 41. From the stock of 1M $AgNO_3$ solution, different concentrations starting from 1mM - 50mM of 90mL of $AgNO_3$ solution were tested with 10mL of the fruit juices.

2. Characterization of AgNPs

Colloidal solutions of AgNPs showed a very intense colour, which are absent in the bulk material as well as formation of individual atoms. The AgNPs formed are indicated by the colour change observed which are due to the excitation of surface plasmon vibrations in the AgNPs (Darroudi *et al*., 2011). A distinct colour change was observed within 24 hrs as the solution turned into dark colour from normal colourless solution at room temperature suggesting formation of AgNPs. The reduction of Ag^+ was confirmed from the UV–VIS spectrophotometer, TEM, EDX, SEM, FTIR and XRD.

- UV-VIS Spectroscopy: The coloured nanoparticle solution showed a peak between 450-470nm. In most of the studies, a UV-VIS spectrophotometer was used to measure the optical density of solutions/suspensions.
- Transmission Electron Microscopy (TEM): TEM showed the shape and crystal structure as well as size of the particles. The grid for TEM analysis was prepared by placing a drop of the nanoparticle suspension on a carbon-coated copper grid and allowing the water to evaporate inside a vacuum dryer. The grid containing silver nanoparticles was scanned by a Transmission Electron Microscope.
- Energy Dispersive X-ray Spectroscopy (EDX): These techniques are mainly used to determine the elemental composition of a sample. This study was used to confirm that the nanoparticle suspension contained only silver(Roy *et al*., 2013).
- Scanning electron microscope (SEM): SEM technique was employed to visualize the size and shape of Ag nanoparticles. This scanning electron micrograph was taken using a Scanning electron microscope in which the dried powder of the silver was placed on carbon-coated copper grid(GnanaJobitha *et al*., 2013).
- Fourier – Transform Infrared Spectroscopy (FTIR): The FTIR measurements was used to identify some of the possible biomolecules responsible for the reduction of the Ag^+ ions and the capping of the bio-reduced AgNPs synthesized by broth (Ahmad *et al*., 2011).
- X-Ray Diffraction (XRD): this technique provided characteristic peaks which gave information on the crystallinity and purity of the AgNPs(Roy et al., 2014).
- Dynamic Light Scattering (DLS): Dynamic light scattering (or Photon Correlation Spectroscopy) is an important technique generally used to realize the size distribution pattern of very small particles present in suspension or solution. This light scattering

technique was used in this study to realize the size distribution profile of biologically synthesized AgNPs(Roy *et al*., 2013).

3. Factors affecting synthesis of AgNPs

The major physical and chemical parameters that affected the synthesis of AgNP are reaction temperature, metal ion concentration, extract contents, pH of the reaction mixture, duration of reaction and agitation. Parameters like metal ion concentration, extract composition and reaction period largely affected the size and shape of the AgNPs (Kora *et al*., 2010). However, most of workers have synthesized AgNPs at room temperature (25˚C to 37˚C) range.

4. Summary of work related to green synthesis of AgNPs

	Author	Reducing agent	Operating conditions	Characterization	Application
1	Jain *et al*., 2009	Papaya juice extract	1mM $AgNO_3$ solution Room temp 3 hrs	UV- Visible FTIR XRD SEM	Antimicrobial activity- *Escherichia coli* and *Pseudomonas aeruginosa*
2	GnanaJobita *et al*., 2013	Filtered solution of pomegranate juice extract	1mM $AgNO_3$ solution Room temp 3 hrs	UV- Visible FTIR SEM EDX	Antimicrobial activity - *Bacillus subtilis*, *Klebsiella planticolae*
3	Roy *et al*., 2013	Grape juice extract	20mM $AgNO_3$ solution Room temp 24-48 hrs	UV- Visible DLS EDX TEM	Antimicrobial activity - *Bacillus subtilis* and *Escherichia coli*
4	Elumalai *et al*., 2014	Filtered coconut water	1mM $AgNO_3$ solution 80°C	XRD SEM EDX FTIR	Metabolites and proteins served as capping agents.
5	Roy *et al*., 2014	Apple juice extract	3, 5, 10 and 15mM $AgNO_3$ solution Room temp 24 hrs	UV- Visible TEM XRD	Antimicrobial activity- bacteria- *Staphylococcus aureus, Klebsiella pneumoniae and Escherichia coli* and two fungi- *Aspergillus niger and Aspergillus wentii*

6	Rao *et al*., 2014	Decanted aqueous filtrate of lemon	1-5mM $AgNO_3$ solution Room temp	UV-Visible SEM AFM	Antibacterial action to *E. coli and B. subtilis*
7	Muzaffar *et al*., 2018	Orange fruit juice Seed Peel	0.5, 1 and 2mM $AgNO_3$ solution Room temp 30 mins	UV- Visible FTIR	Antimicrobial activity
8	Masum *et al.,* 2019	Amala juice extract	1mM $AgNO_3$ solution 65°C 24 hrs	UV- Visible XRD EDS FTIR TEM	Antimicrobial-activity-Acidovoraxoryzae

4. Application of AgNPs.

The anti-bacterial actions of AgNPs are quite complex and not well studied. Their mechanisms are only tentatively explained. The antimicrobial action of AgNPs can be categorized in two types: the inhibitory action and bactericidal action. In the former strategy bacterial cells are not killed but their division is prevented whereas in the later bacterial cells will die due to the action of AgNPs (Perni *et al*., 2014). Antibacterial activity of the synthesized AgNPs was determined using agar disc diffusion assay method (Mahitha *et al*., 2011). Most of the papers have tested against two to three bacteria, one with gram positive and the other as gram negative. The zone of inhibition was measured with appropriate controls. As silver ions and silver nitrate both show antimicrobial activities, hence it was observed from the reports of the papers that AgNPs also showed antimicrobial property showing maximum zone of inhibition than silver nitrate. Hence, due to their antimicrobial properties AgNPs have been used widely in medicine, textile coatings, food storage, dye reduction, wound dressing, antiseptic creams and a number of environmental applications (Lakshmanan *et al*., 2018).

The AgNPs exhibited antifungal action against various fungi (Bankar *et al.,* 2010), by disrupting the structure of the cell membrane and by destructing the membrane integrity, thereby the inhibition of the budding process has been attributed to be responsible for the antifungal action of AgNPs against C. albanicans species (Kim *et al*., 2009).

The AgNPs have been used as therapeutic agents, as glyconano sensors for disease diagnosis and as nano carriers for drugs delivery. Reports are also available on the use of AgNPs in radiation therapy, in H_2O_2 sensor, in ESR-Dosimetry, as heavy metal ion sensors and as catalyst for reduction of dyes such as methylene blue (Srikar *et al*., 2016).

Conclusion:

The green methods used for the synthesis of AgNPs are very convenient. The fruit juices are mixed with $AgNO_3$ solution gave good results in formation of AgNPs as seen in many research works. Different shapes and sizes of silver nanoparticles can be prepared. The applications of these nanoparticles are used for various purposes in medicines and other fields. The potential of AgNPs for their use as drug carriers in cancer therapy, as biosensors for metabolites and pollutants, as catalyst etc. is quite high and requires intensive and integrated research.

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Gut and The Brain: Body's Most Astounding Connection

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Introduction: The gut is one of the main digestive organs in the human body. It carries out primary functions like breakdown of macromolecules and absorption of nutrients into blood. It brings about these functions with the help of the microorganisms present in the gut. The gut is known to house approximately 100 trillion microorganisms (Wang H & Wang Y, 2016). These microorganisms altogether are known as the 'gut microbiota.' Out of the total, 80% of microorganisms are present in the human gut (Wang H & Wang Y, 2016). The human gut harbors a high number of microbial species and may weigh about one kilogram which is approximately equal to the size of a human brain. These microorganisms are known to play very important roles. They act as intestinal barriers and can alter the permeability of the intestinal wall (Wang H & Wang Y, 2016). They are also known to have immunological functions. They help in the maturation of the innate immunity system by occupying voids in the gut which would otherwise be colonized by opportunistic populations. They also help in drug or poison detoxification owing to their diverse metabolic activities.

Various activities of the gut microbiota are known to have an effect on the local plexus forms the 'Enteric Nervous system.' By this we understand that the functions of the gut microbiota are not just limited to simply breakdown of nutrients. Due to its functional dynamicity, this cohort can be regarded to as an individual entity. The gut population is highly diverse. An infant acquires its gut population from the mother. By the age of 1, the gut population of a child is completely flourished like that of an adult (Wang H & Wang Y, 2016). Every individual's gut population is different. This diversity is brought about by many factors like depending on one's diet, external climate also determines the colonizing populations and individual ailments like intolerance, autoimmune disorders. Stress is also known to alter gut microbiota.

The effects on the gut's beneficial bacteria can be reflected in one's health. Not only can the gut bacteria be affected by multiple factors, but it has recently been discovered that the gut bacteria can also affect the wellbeing of an individual. The gut bacteria can make a significant impact on various bodily functions. The most remarkable effect that has recently come to light is the effect of the gut microbiota on the human brain.

The gut microbiota has been known to affect an individual's behavior. It affects one's emotional perception, pain modulation, responsiveness to external events (Emeran M, et al, 2015). The actual mechanism of how these microorganisms are causing effects in the brain is unclear. However, with an individuals' mental wellbeing is the need of the hour, research is constantly looking for answers which could solve this mystery. Of all, the gut-brain

interaction has taken fancy to many scientists. The effect of diet and the microorganisms breaking them down on an individual's mental health is something that would unravel many interesting facts. Thus with constant quest for understanding this fragile interaction of the gut and the brain, the answers to these facts are not far away.

History: Since time immemorial it has been said, 'You are what you eat.' Our ancestors too were quite aware of the fact that what we ingest has an overall effect on the mind and body. Back in the day, the idea of 'gut microbiota' per se was not very well known. However, people knew the importance of the wellbeing of the gut for a healthier individual. During the 19th century, due to urbanization and modernization, the eating habits of an individual began to change. Sedentary lifestyle, lack of exercise and change in diet drastically affected the common man's gut. As a result, doctors started deducing that an unhealthy gut could lead to various mental illnesses which in today's world can be called depression, anxiety, insomnia. At that time, light was mainly shone upon bad consumption of food leading to an unhealthy gut. For example, consumption of alcohol would lead to the increase in gas and uneasiness in the stomach and this would result in the consumer being very cranky or having a bad temper (Miller I, 2018). The idea of gut microbiota hadn't struck by then. However, doctors and researchers would frantically search cues towards understanding the gut and its wholesome effect on the overall health of an individual.

Normal gut microflora: To understand how our gut microbes, impact our body functions, we need to know their normal conditions and functions in our body. Of all the digestive organs, the stomach may be sterile or may contain a sparse bacterial population due to the acidic environment. The human gut flora mostly comprises of 150-400 species of populations belonging to the following phyla*: Bacteroidetes, Firmicutes, Actinobacteria, and Proteobacteria* with *Bacteroidetes* and *Firmicutes* comprising of about 90% of the microflora. (Davenport E, et al, 2017). *Bacteroidetes* are dominant in the gut and they mainly help in digesting carbohydrates (Enders G, 2014). The Firmicutes phyla consists of approximately 200 different genera including *Lactobacillus, Bacillus, Clostridium, Enterococcus, and Ruminicoccus* (Rinninella E, et al, 2019). *Ruminicoccus* is known to help in digesting the components of the plant cell wall (Enders G, 2014). Lactic acid bacteria and *Bifidobacteria* are known to be indigenously present in a child's or is acquired during the process of digestion (Zhang Y, et al, 2015).

The gut microbiome of individuals is more or less the same yet unique. As ironic as it may sound, this statement will only leave us baffled! But not after we consider the following points. An individual's microbiota is determined by several factors: Type of delivery is a major determining factor as the fetus' intestines are sterile and colonization in the intestines take place in accordance to what comes in contact with the fetus. A normally or vaginally born fetus' microbiota will show resemblance to that of the mother's vaginal microbiota. Such infants are known to have the following communities in their microbiota: *Lactobacillus, Prevotella, and Sneathia, Bifidobacterium longum and Bifidobacterium catenulatum.* Also some facultative anaerobic species such as *Escherichia coli, Staphylococcus, Bacteroides fragilis,* and *Streptococcus* are observed in the guts of such infants. Now the children born by cesarean

section (C-section), their microbiota is colonized by populations present in the hospital environment and on the mother's skin. Their gut shows the presence of the following communities: *Staphylococcus, Corynebacterium, Propionibacterium spp., Escherichia, Shigella, and Bacteroides species*.

It has been observed that children born by C- section exhibit far less diversity in their gut microflora with respect to those being born by normal delivery. This renders the former group of children vulnerable to several immune disorders such as asthma, systemic connective tissue disorders, juvenile arthritis and inflammatory bowel disease (Rinninella E, et al, 2019). Breastfeeding also affects the child's gut microflora. Lactoferrin (LF), an important component in human breast milk helps in favourable colonization of beneficial bacteria (Rinninella E, et al, 2019). The gut microflora varies even along the gut with the duodenum having a population density of 10^1 to 10^3 CFU (Colony Forming Units) /mL. The bacterial density in the jejunum rises to 10^4-10^7 CFU/mL while that of the ileum is 10^4-10^7 CFU/mL and has a microbe community similar to that of the colon. Along with these, progressing age of an individual, external climatic conditions, eating habits and intake of antibiotics can alter the composition of the gut microflora often. These kinds of minute changes lead to uniqueness of one's gut microbiota.

Gut brain interaction: Before even microbiota can be considered, the question at hand is how does such a distant organ like the gut, influence the brain. It is known that the gut epithelia has several sensory cells called the Neuropod cells (Kaelberer M, et al, 2018). These cells are in continuous contact with the intestinal atmosphere. All these cells in unity conduct impulses to the brain via what is known as spinal afferent nerve. The Vagus nerve also conducts impulse from the intestine to the brain (Sudo N, 2019). This was proven by an experiment involving sub diaphragmatic vagotomies in mice. Mice that underwent vagotomies showed fewer anxiety-like behaviors than those who had intact vagus nerves (Bravo J, et al, 2011). Information from these nerves are carried and delivered to the Hypothalamus-Pituitary Axis. Thus, it could be said that the Hypothalamus-Pituitary Axis, the afferent nerves and the enteric plexus bring about the gut-brain interaction (Sherwin E, et al,2016). Now the question arises as to why would it be so necessary for the brain to receive impulses from the gut. Well, the brain is an isolated organ, which is guarded by several barriers. At the same time the brain is the central processing organ and it ought to know the status and the functioning of other organs. Hence impulses from the gut pervade the brain about the status of the gut. This information then helps the brain retain the body to homeostasis.

Effect of gut microbiota on the brain: As from the above facts we understand that the gut microflora ought to be fairly in balance for an individual's wellbeing. However, in nature, having an ideal balance is a far off goal. The body is always working towards achieving equilibrium. And while doing so, alterations are bound to take place. These changes if happen to be extreme then only will lead to chromic condition. Otherwise the human body by itself has immense capability to control situations and resumes working towards equilibrium. While this process carries on, it has been noticed that there is a strong

connection between the gut microbiota and the brain. External changes or even the type of food that we consume is known to have some effects on the microbiota (Singh R, et al, 2017). For example, people consuming a lot of beef happen to have higher counts of *Bacteroides* and *Clostridia* and lower counts of *Bifdobacterium adolescentis* when compared to vegetarians (Hentges D, et al, 2019). Changes in the gut population might lead to a cascade of changes like intestinal secretions, change in metabolizing mechanism by the gut flora or even secretion of several components by them, like by products. These interactions and changes are sensed by the local sensory cells or the Neuropod cells. These impulses are then carried by the afferent intestinal nerves and the vagus nerve. These impulses are known to reach the areas of the brain which are responsible for emotions and self-awareness. Also these impulses are known to affect hormones like ghrelin and serotonin (Fukui H, et al, 2018). These neuroendocrinal hormones then in turn are responsible in setting our mood in accordance to their levels which are affected by several factors, impulses caused by the gut microbiota being one of them. The actual mechanism as to how this effect is brought about is still unclear. This explains how chocolates can be mood elevators and why people binge eat when they are in a depressed state. Impulses caused due to actions of the gut microbiota are also known to affect one's cognitive abilities to an extent. Thus inability to work or concentrate to one's best ability on an empty stomach is now justified.

Effect of brain on the gut: Now that it is clear that the brain is receiving signals from the gut, it is obvious that the brain would respond to the gut by sending back signals as well. Thus it is called Bidirectional signaling. As the gut is working as the brains' informant, the brain will elicit responses in accordance to the same. For example, during times of nervousness the brains' hormones are continuously being secreted in the body. The gut microflora works accordingly. As a result, there might be alterations made in various aspects of the population, leading to several physiological changes in the gut. These impulses are picked up by the sensory nerves and taken to the brain. When the brain realizes that the body has to focus on the task at hand which is making the individual nervous, it'll command the body to increase the blood floor to the brain rather than to other organs like the intestine. As a result, far less energy is spent on digestion then than otherwise and this can lead to conditions like diarrhea or constipation (Enders G, 2014). This is why we experience an uneasy feeling in the gut when we are under stress. Hence it could be said that our emotional state has enormous impact on our gut and vice versa. This also explains why some of us loose our appetite when we are low while some of us tend to over eat.

Emotion and the gut: Ever since urbanization, food and eating habits have changed drastically. This has proven to alter the gut population to quite an extent. Changes in the host microbe relationship has been observed due to the same (Chassaing B, et al, 2019). This could explain why the masses are experiencing different kinds of emotions in a short period of time, which wasn't observed back in the day. Globalization makes different kinds of foods available to consumers all across the world. As a result, the body isn't ready to digest food which wasn't digested by our ancestors thus, rendering our microflora clueless as to go about digesting it. This leads to various conditions pertaining to an upset stomach. All of these factors results in the weakening of the gut microflora which becomes easily vulnerable

to imbalance. The combined effect of a poor gut oftentimes results in affecting the individual's psychological health. This is one of the major reasons why there is an increase in the number of patients suffering from emotional stress. Tackling emotional illnesses is a pressing priority at the moment. Probiotics are being considered to be novel and an effective way to deal with problems like depression, anxiety and more. Functional MRI studies in humans and c-Fos (a marker of neuronal activity) in rats have shown that ingestion of good bacteria reduces emotional reactions in the brain responsible for behavior, mood, viscerosensation, and somatosensation (Goehler L, et al, 2008). Areas of the brain responsible for these regions include the amygdala, insula, periaqueductal gray, and prefrontal cortex (Tillisch K, et al, 2013). GABA, an inhibitory neurotransmitter in the brain is responsible for regulating psychological activities in the brain. Studies have shown that administration of *Lactobacilli* and *Bifidobacteria* have the same effects like that of antidepressants on GABA (Bravoa J, et al, 2011). Thus, probiotics are being considered as a better resort to battle emotional imbalanace than antidepressants. Studies show that administration of *Lactobacillus* and *Bifidobacteria* supplements for 8 weeks to patients and for a month to normal individuals, resulted in improved somatization, anger and hostility, anxiety, and depression in both the categories. Hence probiotics could help in improving the public health. The probiotics used to conduct human studies are *Lactobacillus rhamnosus, L.helveticus, L.casei (strain Shirota), L.bulgaricus, L. lactis, Bifidobacterium animalis,* and *B.longum*.

Conclusion: Gut bacteria perform more activities than just aiding in digestion. It affects the emotional cortex of the brain and thus helps in determining one's mood. The mechanism in which this interaction takes place is still not known. Recently, the number of mental illness cases have been increasing with gut imbalance being one of the major cause. Irrespective to the cause of depression, administration of probiotics is seen to elevate mood. Administration of probiotics could help in improving people's health and lifestyle however still more research has to be carried out in this direction.

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The Gene Fairy Godmother: CRISPR-Cas9

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Clustered regularly interspaced short palindromic repeats (CRISPR)-Cas9 systems are renowned acquired immune systems that are rife in archae and bacteria. The first CRISPRs were identified 30 years ago by Yoshizumi Ishino in Escherichia coli in the analysis of the gene in charge for isozyme conversion of alkaline phosphatase. Emmanuelle Charpentier and Jennifer Doudna gave critical information that was required for elucidating the mechanism of natural CRISPR-Cas9 system and showed how this system could be used as efficient, programmable molecular scissors. Dr. Feng Zhang and his team harnessed this system for genome editing by demonstrating targeted genomic cleavage in human and mouse cells. Cas9 a nuclease, guided by small RNAs induces double stranded breaks in the target DNA (Wu *et al*., 2014). The target DNA then undergoes DNA repair mechanisms either through non-homologous end joining (NHEJ) or through homology end joining (HEJ) (Redman *et al*., 2016). NHEJ could be used to achieve gene knockouts though insertion/deletion mutations. By harnessing HEJ and providing a synthetic repair template precise gene editing could be achieved. In large genomes many sequences could be similar or homologous to the target sequence and so CRISPR-Cas9 might unintentionally cleave these non-target sequence, hence giving rise to off-track mutations (Lander *et al*., 2016). There have been continuous efforts to reduce these off-track mutations and ultimately enhance the CRISPR- Cas9 technology. Although Cas9 has already been extensively been used as a research tool, a particularly exciting future direction is the development of Cas9 as a therapeutic tool for genetic disorders. Somatic gene editing is being considered seriously and some of the research has reached human clinical trial stage. In contrast, germ line editing raises several ethical, social, legal and safety issues.

Though gene editing techniques like CRISPR/Cas9 have their limitations, the urgent need of a cure for genetic diseases is high. In its inception CRISPR/cas9 had promised the goal of curing over six thousand genetic diseases and has only now started being used as a therapy, rather cautiously for cancer. Clinical trials are in progress for treating cancers, eye diseases and blood disorders. These trials are relatively harmless as they are intended to affect specific cells only, without influencing germinal cells. Therefore, they will not pass to future generations. CAR-T immunotherapy is a good example of gene editing used in medicine today.

Immunotherapy is popularly used to treat cancer by boosting the body's immune system to fight the cancerous cells. T cells are vital immune cells present in our body that defend it from intracellular and extracellular pathogens and also cancerous cells. These T cells have particular receptors present on their surface called PD1 receptors that act as checkpoints in the body by identifying safe and unsafe cells. They recognize safe cells when they come in contact with PD-L1 on the subsequent cells surface. Many cancer cells have the ability to cloak themselves with this molecule making them seem like "safe" cells and escaping the T cells radar. Therefore, in the CAR-T immunotherapy the scientists genetically engineer T-cells that will attack cancer cells. "CAR" stands for Chimeric Antigen Receptor which is artificially engineered and added to the surface of the T cell, helping it identify specific antigens present on cancerous cells. This is an ex vivo gene editing technique where the researcher harvests T cells and engineer them in the lab (Liu *et al*., 2018). Now, these special receptors allow the T cell to attach to specific antigens or proteins that are specific to cancer cells.

The engineered T cells of the CAR-T immunotherapy can be used in conjunction with the checkpoint inhibitors like PD1. CRISPR is used to edit PD1 genes in T cells such that the gene is non-functional and the cancerous cells cannot trick the T cells. Thus, the PD1 disruption can enhance the anti-tumour activity of CAR-T cells (Mcgowan *et al.,* 2020).
In 2017 the Food and Drug Administration (FDA) had approved CAR-T immunotherapy for treatment of children with acute lymphoblastic leukaemia and adults with advanced lymphomas. There has been positive response to the treatment but scientists are unsure whether the therapy would work on solid tumours as well.

Clinical trials are also underway in the treatment of diseases ranging from HIV to blood disorders. Clinical trials of sickle cell anaemia and beta thalassemia are also in process, where the aim is to increase the level of fetal haemoglobin to replace the defected blood cells in adults and children, by editing the patient's haematopoetic stem cells. Trials are also being conducted for the treatment of eye diseases like Leber Congenital Amaurosis, prominent cause of blindness in children which is genetically inherited. This is done by editing eye cells by injecting a virus containing the CRISPR
genome editing tools, into the cells. This is the first clinical trial to be conducted, where the editing will happen inside the body (Ledford *et al*., 2020).
CRISPR techniques are being improved every day and being modified to treat a variety of diseases. Though the outcomes of these studies are not yet known it is a step forward in treating formerly untreatable diseases and disorders.

The advent of gene editing gave rise to the idea of it being used one day as a therapeutic, from treating formerly untreatable diseases to designing babies. But the capricious nature of this technique provides several limitations. He Jiankui, a biophysicist at the Southern

University of Science and Technology, China, revealed in November 2018 that he had used CRISPR/Cas9 to genetically edit the genome of two babies, Lulu and Nana. In his experiment he attempted to make the twins "naturally" immune to the attack of the human immunodeficiency virus (HIV) which is known to cause acquired immunodeficiency syndrome (AIDS). His subjects included parents where the father was HIV+ and the mother was uninfected. He took the sperm and the egg and performed in vitro fertilisation. Subsequently he used CRISPR/Cas9 to genetically edit the genome of the zygote, targeting the gene CCR5. This gene is known to code for a protein receptor on immune cells, that HIV uses to enter the cells. Dr. He Jiankui was trying to make a specific mutation in the gene, CCR5 Δ32. This CCR5 variant, has 32 fewer DNA basepairs and therefore produces a receptor that is too small, such that the HIV fails to enter the cell. Since this mutation is naturally present in several populations, He believed that it would provide innate resistance to HIV. But his experiment missed its target goal. Lulu has one normal CCR5 gene that has missed the CRISPR edit and one 15 bp edit instead to 32. Nana on the other hand has one CCR5 gene missing 4bp and one with an extra base pair. Since these mutations do not naturally occur in nature its repercussions are unknown (Li *et al.*, 2019) This case was a prime example of the lax policy and ambiguous nature of research in human genome editing in China. The public outcry was massive and sparked an intense debate as to where the future of human genome editing was headed.

Things are moving fast in the world of CRISPR-Cas9 technology. Many different applications are being pursued and the only limit seems to be our imagination. In the midst of this anticipation we must find methods to make sure strong ethical and scientific framework is laid so as to make the technology safe and effective.

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Nobel Prize in Chemistry, 2019
The Birth of Lithium Batteries

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The Nobel Prize is a set of annual international awards bestowed in several categories by Swedish and Norwegian institutions in recognition of academic, cultural, or scientific advances. The Swedish chemist, engineer and industrialist Alfred Nobel introduced this and established the five Nobel prizes in 1895. The prizes in the fields of Chemistry, Literature, Peace, Physics, and Physiology or Medicine were first awarded in 1901. The selection process of this prestigious award begins in the early autumn of the preceding year and the winners are announced in October and November. The Prize includes a gold medal, a diploma bearing a citation, and a particular amount of money which depends on the income of the Nobel Foundation. Nobel Prize is either given to one person or can be shared by three persons.

The Nobel Prize in Chemistry 2019 was awarded jointly to John B. Goodenough, M. Stanley Whittingham and Akira Yoshino "for the development of lithium-ion batteries."
Lithium-ion batteries are much in use today as they are used globally to power the portable electronics that we use to communicate, work, study, listen to and search for knowledge. Lithium ion batteries have also enabled the development of long-range electric cars and the storage of energy from renewable sources, such as solar and wind power. The foundation of the lithium-ion battery was laid during the oil crisis in the 1970s.

Stanley Whittingham worked on developing methods that could lead to fossil fuel-free energy technologies. He started to research superconductors and discovered an extremely energy-rich material, which he used to create an innovative cathode in a lithium battery. This was made from titanium disulphide which can accommodate lithium ions (Placke *et al.*, 2017).
The battery's anode was partially made from metallic lithium, which had the ability to release electrons. This resulted in a battery that literally had great potential, just over two volts. However, metallic lithium is reactive and the battery was too explosive to be viable.

And then came to the picture John Goodenough where he predicted that the cathode would have even greater potential if it was made using a metal oxide instead of a metal sulphide. After a systematic search, in 1980 he demonstrated that cobalt oxide with intercalated lithium ions can produce as much as four volts. This was an important breakthrough and led to much more powerful batteries. With Goodenough's cathode as a basis, **Akira Yoshino** created the

first commercially viable lithium-ion battery in 1985. Rather than using reactive lithium in the anode, he used petroleum coke, a carbon material that can intercalate lithium ions like the cathode's cobalt oxide (Whittingham *et al.,* 1975).

The end result was a lightweight, hardwearing battery that could be charged hundreds of times before its performance deteriorated. The advantage of lithium-ion batteries is that they are not based upon chemical reactions that break down the electrodes, but upon lithium ions flowing back and forth between the anode and cathode. (Schmidhuber, 2010).
Lithium-ion batteries have revolutionized our lives since they first entered the market. They have laid the foundation of a wireless, fossil fuel-free society, and are of the greatest benefit to humankind (Placke *et al.,* 2017).

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Nobel Prize in Physiology or Medicine, 2019
On a road for understanding oxygen sensing and cell adaptability

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A long-awaited question has been answered. On 7th October,2019; William G. Kaelin Jr, Sir Peter J. Ratcliffe and Gregg L. Semenza were jointly awarded the Nobel Prize in Physiology or Medicine 2019. The findings of the molecular mechanism on cell adaptability in varying oxygen levels has brought new promising ways to fight diseases like cancer, anaemia, stroke, myocardial infarctions, infections and also wound healing.

Based on the past knowledge, Gregg L. Semenza, a Director of the Vascular Research Program at the Johns Hopkins Institute for Cell Engineering studied the EPO gene and its effect on different oxygen levels in transgenic mice (gene-modified). With his team, he purified EPO in 1977 and its gene was cloned in 1985 (Lin *et al*., 1985). He found that there were DNA segments situated close to the EPO gene that responded to hypoxia. Later, a protein complex, now known as HIF (hypoxia-inducible factors) was found to bind to these specific DNA segments in an oxygen dependant fashion. On further observations, he and his fellow researchers concluded that HIF consisted of two components- HIF-1α and ARNT (DNA- binding proteins or the transcription factors). The experiments done by Sir Peter J. Ratcliffe, Gregg L. Semenza and their work team proved that this mechanism generally occurs in all cells.

Proteasome degrades HIF-1α under normoxia (Aaron Ciechanover, Avram Hershko and Irwin Rose; Nobel Prize in Chemistry,2004) and this degradation is a very rapid process. Under low oxygen levels HIF-1α accumulates in the cell nucleus and is protected from degradation. Ubiquitin bound to the proteasome acts as a marker/tag for protein degradation to take place (Kamura *et al*., 2000). While studying the von Hippel-Lindau's disease (VHL disease), William G. Kaelin Jr. revealed the role of VHL gene in hypoxia. His experiments showed that cancerous cells with a non-functional VHL gene express abnormally high levels of hypoxia-regulated genes; but when the functional VHL gene was reintroduced the levels drop down and came back to normal. This was a key discovery which made way for new research strategies in cancer research. William G. Kaelin Jr. and his fellow researchers proved that VHL directly interacts physically with HIF-1α.

In 2001, it was already known that a process called prolyl hydroxylation allows the recognition and binding of VHL to HIF-1α. This protein modification uses oxygen-sensitive enzymes called as prolyl hydroxylase. At present there are 70 such enzymes families that depend on oxygen for them to function. The mechanism on how these enzymes work and function in these conditions is still unknown. The prolyl hydroxylases responsible for this binding were identified by Sir Peter J. Ratcliffe and the others. On further research they discovered that oxygen-dependent hydroxylation regulates the function of HIF gene activation.

Around the same year other published research papers showed that HIF hydroxylase inhibitors (HIs) decrease cellular oxygen consumption depending on their selectivity. This explains the reason behind HI effects in the treatment of hypoxia-associated diseases like chronic inflammation, ischemia-reperfusion injury and anaemia in chronic kidney disease patients. The anaemia caused in patients suffering from chronic kidney diseases have suppression of the EPO gene. Since erythropoietin is mainly produced in the kidney, this suppression causes decreased production levels of EPO. This oxygen sensing mechanism helps regulate t. he formation of new blood vessels and is a controlling factor for the production of RBCs. In cancer cells, this mechanism helps in cell proliferation, during foetal development, oxygen sensing is required for the proper functional placental development and the overall development of the foetus. This ground-breaking discovery is the basis of future newly modified drugs and therapies to combat hypoxia-associated diseases. Roxadustant, a pan-prolyl hydroxylase inhibitor, has been proven to treat anaemia due to kidney failure. (Zhang *et al.*, 2019)

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Nobel Prize in Physics, 2019
Odes of the Universe

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The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos", and was jointly shared by three scientists: James Peebles, Princeton University, USA, "for theoretical discoveries in physical cosmology" receiving half the credit; and Michel Mayor, University of Geneva, Switzerland, and Didier Queloz, University of Geneva, Switzerland, and University of Cambridge, UK, "for the discovery of an exoplanet orbiting a solar-type star", sharing the other half of the credit.

Cosmology is the study of the universe's origin, structure and prediction of what its ultimate fate might be. Dr Peebles, whose study in this field has spanned for over five decades, has been recognized as having laid the theoretical framework that led to our current understanding of the shape of the universe, from the Big Bang to the present day. With his seminal theoretical tools and calculations, he interpreted that the cosmic microwave background are traces from the primitive stages of the infancy of the universe, and which has allowed for the discovery of new physical properties, along with enabling physicists to create an understanding model of the universe. He also found that only 5% of the observable universe is known to us in the form of stars, planets and people, while the remaining 95% is mysterious and not easily determinable, made up of what physicists have termed dark energy and dark matter. This so-called dark energy is said to be the driving force behind the expansion of the universe, while dark matter is the invisible substance that appears to hang around galaxies, revealing itself only by its gravitational draw.

Meanwhile, Swiss astronomers Michel Mayor and Didier Queloz announced, in October 1995, the first discovery of a planet outside our solar system, called an exoplanet. This planet, named 51 Pegasi b, in the constellation Pegasus, is a gaseous ball about 150 times more massive than Earth, and has a surface temperature of about 1000°C. This discovery was instrumental in challenging preconceived notions about planetary systems, and, as a result, as of 2019, about 4000 more exoplanets have been discovered. Using custom-made instruments, the duo discovered the Jupiter-like exoplanet from the Haute-Provence Observatory in southern France, using a sophisticated technique known as Doppler spectroscopy, instead of the frequently utilized "transit method".

This technique, making use of its namesake the Doppler Effect, measures the tiny "wobble" of a star that occurs as the star, and a planet that swings around it, move around a common centre of gravity. As a planet's gravity pulls its star towards Earth, light from the star is shifted towards the blue wavelengths of the electromagnetic spectrum, and this shift was measured. 51 Pegasi b was also discovered to be just about 55 light years away from Earth. This discovery defied previous ideas about how a large planet, similar to Jupiter, should behave.

These two areas of research, while vastly different in scope and topic, have revolutionized the way we view the universe, from its earliest moments to the present day, and into the distant future; and our place within it.

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A glimpse into research at premiere Institutions across India
This issue: **Indian Institute of Science (IISc), Bengaluru**

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Department of Life Sciences

This article seeks to bring to a wider audience, a flavour of research work in prominent labs across India as pointers to possible areas of interest for further work.
This issue focuses on the Labs at the Indian Institute of Science (IISc), Bangalore and gives a glimpse into the various fields of research conducted in the Institute. It also gives an idea of similar research conducted in other labs across the country.

Featured Institute:
Indian Institute of Science(IISc), Bengaluru

Established in 1911 the Indian Institute of Science (IISc), Bangalore is one of the premier research institutes of India. The Institute hosts more than 40 departments including the divisions of biological sciences, electrical sciences, interdisciplinary research, mechanical sciences, physical and mathematical sciences. Highly motivated Undergraduate, Postgraduate and PhD students under the guidance of extremely capable Professors and mentors have brought about more than 1700 publications in the year 2019 alone, in the form of research articles in journals, conferences, short communication, book chapters etc.

Research in Superconductivity

Featured Division: **Chemical Science**
Lab in Focus: **Solid State and Structural Chemistry**

The physical property of a substance wherein its resistance becomes zero, the expulsion of its magnetic fields occurs and hence it becomes a superconductor, is called Superconductivity. This property of superconductivity occurs in all metals when they are cooled below a certain temperature, and hence there is a need to find a metal that can be a superconductor at high temperatures.
The Primary Research of this group at IISc deals with nanoparticles and how they differ from the bulk material. This group recently published an article in which they have claimed to have made a nanostructured material with silver particles embedded in a gold matrix that is capable of behaving like a superconductor at room temperature.
Researcher: Dr. Anshu Pandey

Other Labs in India working on Superconductivity:

- The Superconductivity Lab at Tata Institute of Fundamental Research (TIFR), Mumbai
- The High Temperature Superconductor Lab at Indian Institute of Technology (IIT), Roorkee
- The CSIR-National Physical Laboratory, New Delhi

Other labs in the Division of Chemical Sciences at IISc include Inorganic and Physical chemistry lab, which is working on Spectroscopy, Polymer chemistry, Bio-inorganic and Biomimetic Chemistry.
The Organic chemistry lab has a division called Chemical biology, working on (among other topics) peptidomimetics, which are sugar-linked RNA- linked amino acids, and Bioactive switch peptides

Research in mechanical designing of prosthetics

Featured Division: **Mechanical Sciences**
Lab in Focus: **Centre for Product Design and Manufacturing**.

Optimal mechanical designing of prosthetics allows for individuals who have lost their limbs due to accidents or disease to regain some function. Brain Computer Interface (BCI) Research and development of Intelligent prosthesis is widely beneficial for amputees.
This Lab has created PURAK which is a trans-radial prosthetic arm. It is controlled by the user through myo mechanical control interface, which allows the user to control it intuitively. Myo mechanically controlled devices are those devices that are controlled through the electric potentials that are generated on the contraction of the muscle. Another feature of this prosthetic is the ability of the user to be able to feel how hard the object being held is.
Researchers: Prof. Dibakar Sen, Prof. B Gurumorthy

Other Labs in India working on Prosthetic Arm Research:

- The Rehabilitation Research and Device Development (R2D2) lab at IIT, Madras
- Centre for Biomedical Engineering, IIT Delhi

The Division of Mechanical Sciences at IISc also has research pertaining to Aerospace Engineering, Earth Sciences, Product Design and Manufacturing, Sustainable technologies, and Climate Change Studies.

Research in models to predict the occurrence of events

Featured Division: **Physical and Mathematical Sciences**
Lab in Focus: **Department of mathematics**

The broad research areas in this lab include research on Probability, Combinatorics, Statistical physics, Mathematical physics and Experimental mathematics. Mathematical Research is helpful in creating models to predict the occurrence of real events and determine trends in data sets. A recent Publication from this lab explains the outcome of random walks in varying conditions.
Researcher: Arvind Ayyer

Other Labs in India working on Mathematics

- The Mathematics Department at The Institute of Mathematical Science, Chennai
- The Mathematics Department at IISER, Pune
- Indian Statistical Institute, Kolkata

Research in Electronics

Featured Division: **Electrical Science**
Lab in Focus: **Electrical Engineering**

Power **Electronics** is the field that deals with the application of solid-state electronics to the control and conversion of electric power. Traditionally, silicon semiconductors have been used in electronic devices to reduce the loss of power.
In the Indian scenario, research on similar highly efficient but cheaper semiconductor devices is advisable. In collaboration with three other labs from the same department, recently, the division of electrical science has been involved in production of India's first e-mode gallium nitride power transistor.
Researchers: Prof. G. Narayanan, Prof. Vinod John, Dr. Kaushik Basu

Other Labs in India working on Power Electronics

- The Power Electronics for Renewable Integration (PERI) Lab at IIT, Kanpur
- The Applied Power Electronics Lab at IIT, Bombay
- The National Mission on Power Electronics Technology (NaMPET)

Associated fields of work in this lab are Automation and Robotics and Electronics

Research in Neurodegenerative Disorders

Featured Division: **Biological Sciences**
Lab in Focus: **Centre for Neurosciences**

Neurodegenerative Disorders most often affect the brain regions of the ageing population which include diseases like Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, etc and are irreversible. These diseases render a person incapable of performing everyday tasks.
This lab has been studying Alzheimer's disease in transgenic mice and has recently published a paper that explains the loss of neuronal network over different time periods leading to consequent cognitive dysfunction. There is a critical period after the onset of the disease seen through the deposition of Amyloid plaques wherein the brain can maintain its connectivity by making alternate connections but after a certain point the damage becomes irreversible.
Researcher: Prof. Vijayalakshmi Ravindranath

Other Labs in India working on Neurodegenerative Disorders

- The CNS-CVS related disorders lab at CSIR-Central Drug Research Institute, Lucknow
- The National Brain Research Centre (NBRC), Haryana
- The Kaushika Lab, part of Department of Biological Science (DBS) at TIFR, Mumbai
- The Raychoudhary Lab, at Centre for Cellular and Molecular Biology (CCMB), Hyderabad

The Division of Biological Sciences also has Departments pertaining to Ecology, Biophysics, Biochemistry and Microbiology and Cell Biology

Research in Ecology

Featured Division: **Biological Sciences**
Lab in Focus: **Centre for Ecological Sciences**

Studies in ecological science give us an insight into the interdependence between humans and nature. Even minor relationships between certain species can cause major effects on the overall ecological community.
At the Centre of Ecological Sciences, research is focused on the frontier areas including plant and animal populations and communities. Quantitative techniques such as statistical, computational and mathematical modelling are used in the lab to create synthetic models of ecological systems, including patterns that would be seen in the event of catastrophes.
Researchers: Renee M. Borges, N.V. Joshi
Other Labs in India working on Ecology

- The Evolutionary Biology Lab at JNCASR, Bangalore

- Behavioural and Evolutionary Ecology Laboratory at IISER, Trivandrum

Other work in Ecology at the IISc includes studying interesting animal behavior by observation of social communication and Predator-prey interactions between animals affecting communities and populations, from insects to elephants.
Areas related to evolutionary research include plant-animal interactions phylogenetics, biogeography and animal venoms.
Climate change and conservation studies involve investigating the pressures caused by human activities on the Environment and remedial measures to conserve and restore and manage nature.

Research in Infectious Diseases

Featured Division: **Biological Sciences**
Lab in Focus: **Department of Microbiology and Cell Biology**

Infectious diseases such as Tuberculosis, Typhoid, HIV etc, cause the death of innumerable individuals every year. Research to understand the exact mechanism of the pathogenesis and development of better treatment is the need of the hour, especially in a developing country like India, which is more susceptible to such diseases.
At the Microbiology and Cell Biology Lab research is carried out regarding the mechanisms of bacterial cell division. A recent publication from this lab talks explores the possibility of development of drug resistance in certain strains of *Mycobacterium tuberculosis* through the generation of a pool of mutants caused by high oxidative stress.
Researcher: P. Ajitkumar

Other Labs in India working on Infectious Diseases

- Infectious Disease Biology Lab at Institute of Life Sciences, Bhubaneshwar
- National Institute of Virology, Pune

Other research in the Department of Microbiology and Cell Biology includes Mechanism of pathogenesis in viruses, bacteria and fungi, cell signaling, plant pathogenesis and development and animal cell development and lifestyle diseases.

Research in Biophysics

Featured Division: **Biological Sciences**
Lab in Focus: **Molecular Biophysics Unit**

Studies in the field of biophysics help us to understand the functioning of biological systems in terms of principles of physics and chemistry.
At IISc, research in biophysics among various other things, is carried out to understand membrane biophysics. Spatiotemporal organization of the membrane is dependent on the lipid composition, and research has been carried out to understand the evolutionary rationale behind maintaining the diverse types of lipids in the membrane of a single cell, mechanisms behind vesicular transport, force induced conformational changes etc. are being studied in the lab. The other fields of research in the Molecular Biophysics Unit at IISc include research in protein folding and structure, drug-target and physical interactions, 3D modelling using computers etc.
Researcher: Anand Srivastava

Other Labs in India working in the field are

- Cellular Biophysics Lab at IIT, Bombay
- Department of Biophysics at Bose Institute, Kolkata

The **Department of Biochemistry** is working on molecular mechanisms in genetics such as modification and repair, synapsis and crossing over, cancer biology and therapy. Its section on Systems Biology and Genomic Medicine studies metabolic regulation using mathematical and computer models of molecular interactions and identifying disease controlling activities of phytochemicals. Host-pathogen interactions and immunology is also being studied

The Institute also has many **Interdisciplinary Research** streams, like Nano Science and Engineering, Infrastructure Sustainable Transportation and Urban Planning, Supercomputer Education and Research, Energy and Water Research, Biosystems Science and Engineering - in which Engineers and Biologists work to develop healthcare devices and artificial biomolecules.

The IISc has several Programmes associated with it. One such programme that offers funding to students is the Kishore Vaigyanik Protsahan Yojana (KVPY), a fellowship granted to students in the SYJC and FYBSc who are interested in research. The advertisement for this appears in all the national dailies on Technology Day (May 11) and the Second Sunday usually in May/ July every year. The selection is on the basis of an interview. Successful candidate students are sponsored for the tenure of research and gain exposure

We have presented before you selected aspects of work in the labs, we therefore encourage readers to access further information from the respective organizations for further details as well as for associated areas of research.

And This Is Where It All Starts

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"There are three kinds of lies: lies, damned lies and Statistics."
– Mark Twain

Today, we live in a world exploding with data and knowledge; but what do we do with it? That's where the Statistics comes into picture. Statistics is the science of collecting, summarising and analysing the data to predict results. Statistics is used not only in modern times but was used also in the ancient and medieval ages: difference is they didn't know it was Statistics!
Statistics at that time was not recognised as a concept but its principles- what we know today- were applied during the ancient times.

The idea of randomness
In the ancient period, people mostly used the concept of chance and randomness. Archaeologists have found some prehistoric artefacts that lead us to believe that they wereused to predict random patterns. One such is the astragalus, a bone found in the heels of sheep, deer and dogs etc. which when thrown lands on four sides. This was found at the excavating site in Egypt which dates back to 5000 years ago. Astragali was used as dice for board games by the Egyptians. Board games were found at the excavating site at Ur in the early 20 century. Many old civilisations like Mesopotamian also used drawing lots, astragali for making decisions often associated with religious practices(David *et al*., 1962; Tabak, 2004) Despite all of this, ancient societies were not able to develop the theory of probability. This may be due to certain ambiguity; as the structure of astragali was non- uniform, and its weight distribution depends upon the age and the species of the animal. Changes in any of these alters the frequency in the game hence no uniform data can be recorded(Tabak, 2004).
AND THE STATISTIC BEGAN…

In 1085, **William the Conqueror**, Duke of Normandy and King of England obtained information about England which was compiled in two volumes called as DOMES DAY book.The data is considered one of the greatest achievements of Medieval Europe(Hald, 2003; Tabak, 2004).
John Graunt (1620-74), is thought to be theforemost person to usediscrete concept of statistics. He was a British shopkeeper, a successful businessman, a city council man, member of militia and officer of a water company. He was inquisitive in nature. His study led to the systematic and quantitative information on human mortality. John studied the bills of

mortality which he used to obtain from the parishes. He used to note the reason of death against every death and recorded the lists of christening and birth. In his only publication, "*Natural and Political Observations Mentioned in a following Index, and made upon the Bills of Mortality*", he described the criteria used for analysis and listed some of his discoveries from the bills. In his book he said that many people look for unusual facts about deaths and so forth, but what is required is collating the data and performing the most suitable computation. What was explicable in his study was his insight of extracting the information from the bill and analysing it to reveal relationship between the numbers. This was the new beginning of an era which would use statistics(Hald, 2003; Tabak, 2004).

Edmund Halley (1656-1742) is permanently associated with Halley's Comet. He predicted the reappearance of the comet but unfortunately did not live long to witness it coming true. Halley too published a paper on mortality rates in the city of Breslau. Halley was interested in Graunt's works but he suspected an error in Graunt's work, since Graunt's work covered a broader area whilst his was more specific. Halley considered migration which occurred rapidly in London and the population was increasing at that time whereas Graunt's conclusion showed that there were more deaths at that time. Halley thought that it was impossible to deduce accurate results without the data of people migrating to and fro London. So he decided the city of Breslau ideal for his study. His data and analysis of the Breslau population is an important contribution to development of statistics(Hald, 2003; Tabak, 2004).
John Graunt and Edmund Halley used simple math and basic arithmetic. Hence their works played an important role in the history of statistics.

Adrien-Marie Legendre is a 19th century French mathematician who contributed to statistics.He was searching for a solution to the problem of predicting the orbit of a comet. The topic of his paper was new methods for the determination of comet orbits. Legendretried to use of collected data of measurements to determine the orbit of the comet. But thesemeasurement had some error which became prominent when more measurements were added to the data.On reducing the data, he found it difficult to predict the error.ButLegendre was faced with the problem by large number of measurements. To tackle his problem, Legendre found a way to use the whole set of measurements and compute them in such a way that they minimized the amount of variation. This method now is called as 'Method of Least Squares.' This discovery was instantly recognised and Legendre's book on cometary orbits was later reprinted several times (Hald, 2003; Tabak, 2004).

In 1809, another mathematician **Carl Friedrich Gauss** published a paper In Latin"Motion of the heavenly bodies moving about the Sun in conic sections". He waited for many years to publish his results. However, Legendre was the first one to publish the paper and introduce it to the school of statistics. But mathematically, method on least squares is not an advanced

tool in the field of statistics. It has many applications and is still a part of introductory statistics (Hald, 2003; Tabak, 2004).

Thereafter, many notable individuals like Karl Pearson, Fisher, and Laplace etc. contributed largely to the development of statistics. Today, fields like Data Science, Business analytics, Biostatistics, Quality control, Epidemiology, etc. have emerged from Statistics which are advanced in their applications. These fields combined with I.T find their use in healthcare, business, industries etc. for systemizing and analysis of large amount of data available which would have been impossible to deal with manually. Indeed, statistics has become an important tool in this era of data explosion.

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Book Review: Statistics without tears

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Title of the book – Statistics without tears
Author name – Derek Rowntree
Year of publication – Initial Year of publication 1981 (Latest edition - 2018)
Publication house – Penguin Books
ISBN – 978- 0-141-98749-1

Statistics without tears is a book well written by a savvy statistician Derek Rowntree. In simple words this book is truly a beginner's guide to statistics for any individual belonging to a non-statistics and non-mathematics background. It is an ordinary looking book of approximately 200 pages filled with knowledge and information.

This book encompasses all the areas of statistics. It starts with the simplified meaning of the term statistics, and elucidates various statistical terms, approaches and applications written in a sequential order. A vivid understanding of basics of statistics is given in this book. The author in the beginning asserts that the readers of this book will clap eyes on the absence of numerical. The absence of which is a distinctive feature of this book in comparison to a regular mathematics and statistics text book. The book starts by highlighting simple everyday tasks to make readers understand how subconsciously folks make statistical decisions and predict things based on collective observations. By using both scientific and non-scientific examples the author further explains, the technique and proper methodology involved in obtaining and collecting data. A lucid explanation of how proper sample is created from the given population, how errors are reduced in creating a sample and how accuracy is achieved is further explained. Step by step various techniques of comparing the data is explained adding illustrated diagrams with tabulations and notation. To make concepts clear author has taken a question answer approach. Questions along with their possible answers are placed at the end of every topic. It is advisable that the readers should avoid dodging the questions, read them and try answering them for vivid understanding of the topics.

The language in the book is kept very simple. The author has made use of intelligible vocabulary for explaining the concepts to make sure that the readers don't have to put strenuous efforts while assimilating the concepts. The author has put his best efforts in attesting the points in order to provide the best explanation for each and every concept. However, in my opinion including a few numerical would have done wonders, as in case of

illustrating comparison between one tailed and two tailed tests, to provide a clear idea of the difference between them. Few numerical examples to solve, would also help to break the monotony one experiences while sitting with the book for longer hours. Nonetheless the book stands out clearly with the explanation that is put together for all the statistical topics. The author ended the book reasoning out, on why it is important to understand the basics of statistics and has highlighted some of its important applications for the readers.

One line from this book present on page 188 I would quote here "I feel I've raised more questions in your mind than I've answered, I shan't be surprised or apologetic". This line in general is very important if we understand how necessary it is to ask questions and search for the best possible answers in order to gain expertise in any field. As I remarked above, this book is really good for anyone interested in statistics as it explains all the topics and concepts very well in a simplified manner. So, in my opinion if you plan to take statistics or if you have forcefully been thrown in this field its better you grab this book sooner. Give this book a good shot to avoid tears during the exams.

Book Review: The Emperor of All Maladies

Janav M Panchal
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Title: The Emperor of All Maladies
Author: Dr Siddhartha Mukherjee
Publication House: Charles Scribner's Sons
Publication Date: 16 November 2010
ISBN: 978-1-4391-0795-9

New York based oncologist Dr. Siddhartha Mukherjee in his chronicle – 'The Emperor of all Maladies' covers not only the history of cancer but also his personal experiences during his early days as an oncology fellow. This Indian-American oncologist and author won the 2011 Pulitzer Prize for General Non-Fiction.

I found this book unique for I could empathize with the author, reflecting back on my own grandmother's battle against lung cancer, thereby making me compulsively read the entire book in one sitting.

Cancer is not merely the abnormal growth of cells, but it is the 'plague of our generation.' In this interesting chronicle, Siddhartha Mukherjee manages to convey not only a forensically precise picture of what he sees but also a shiver of what he feels.

This chronicle engulfs tales of many surgeries discoveries but the central drama proceeds towards a war. A very important war, which only with time one would be able to fathom its significance.

This book is comprised of six chapters, which deal with the various events according to the historical progress in the screening of cancer, its diagnosis, treatment and prevention. In the initial parts of this novel the author describes the early symptoms of cancers, particularly leukemia.

The author assembles a cast of characters: from ancients like Atossa, the Persian queen who self-prescribed mastectomy to get rid of her malignant cancer tumor, Rudolf Virchow, Sidney Farber, John Hunter and many others to the present-day involving Mukherjee's own patients. Also highlighting the cancer campaign which exploded in the 1940's when Mary Lasker and Sidney Farber met up.
Mukherjee describes it as "the coming together of two travelers… each carrying one half of the map." And then in the 1960's their alliance with the then President of the United States, Richard Nixon – led to the passing of the National Cancer Act (1971) – which put forth the

idea of cancer as a sovereign disease and a matter of national concern.

In the subsequent parts of this novel Mukherjee uncovers groundbreaking advancements in the development of the treatment of cancer, including MRI's, CT scans, combination chemotherapy and molecular targeted agents.
Discoveries of the causes of cancer, including viruses, radiations, carcinogens and hormones are also well established.

I particularly relished part four '*Prevention Is the Cure'* this shed light on how we can prevent this menacing disease in the first place. Narcotics, particularly the tobacco and the tar from cigarettes responsible for the much dreaded lung cancer, if not consumed would in turn not cause the cancer.

We also learn about how The Federal Cigarette Labelling and Advertising Act (FCLAA) of 1965 diluted the Federal Trade Commissions (FTC) decision to post the advertisement stating – '*Cigarette Smoking Is Dangerous to Health. It May Cause Death from Cancer and Other Diseases'* to '*Caution: Cigarette smoking may be hazardous to your health*.' Thereby removing the words 'Cancer' and 'Death', initiated by activists, lobbyists, and backed by cigarette manufacturers and the Supreme Court Justice. These techniques were used to minimize the health hazards impact on the smokers mind and maximize the sales, indirectly maximizing the cases of cancer.

Mukherjee many a times portrayes himself as a simple being peeking into a microscope in the depths of the hospital where he is interning, and what he keenly observes is an evil mystery of human life or must I say anti-human life.
This book also depicts how the malignant cells consumed his life, his thoughts and often fogged his vision. He briefly describes his personal battle and how he became immune to it, from carrying out surgical procedures to conversing with patients and their families.

The title of this book '*The Emperor of All Maladies'* is rightly named for Cancer can now be considered as the 'Emperor of All Illnesses', these mutated cells are distorted versions of the very genes that perform the vital cellular functions to sustain our lives. This piece of literature is intensively vivid, as if it were a passionate priest describing Satan. I believe this book will provide hope and clarity to those seeking to demystify cancer.

We are so close to inventing a cure for cancer but we lack the will and the kind of money that went into putting a man on the moon.

If we as humans seek immortality then so, too, in a rather perverse sense, does the cancer cell - Dr Siddhartha Mukherjee

Book Review: Phantoms in the Brain

Shreyasi Chatterjee
Department of Life Sciences

Title: Phantoms in the Brain
Author: V.S. Ramachandran
Year of Publishing: 1998
Publishing House: HarperCollins Publishers
ISBN-13: 978-0-00-725389-0

A light read where you tread the thin line between what is real and what you think is real.

What we call rational grounds for our beliefs are often extremely irrational attempts to justify our instincts.
-Thomas Henry Huxley

Can something you can't see exist, and something you can see, not exist?
What odd questions you say, but V.S. Ramachandran, a renowned (and odd) Indian-American neuroscientist tries to elucidate these questions and few of their answers in his electrifying book Phantoms in The Brain. With a Feynmanesque delight in simple and elegant experiments, Dr. Ramachandran goes on to illustrate numerous mind-boggling attributes of the mind, ranging from patients conjuring up phantom limbs to the curious case of a dignified old woman not aware of the existence of the left side of her body or the befuddling account of a young man who believes is own parents are impostors. This brings into scientific light questions bound to cause your spiral down existential uncertainty such as- *"What is the self? What brings about the unity of my conscious experience? What does it mean to will an action?"*

The writer takes up these questions in evenly spaced, wittily named chapters that you would assume are filled with medical jargon but are instead construed in brilliantly lucid, humorous, and engaging prose. He tackles each of these abstract issues and concepts with utmost openness of mind and dissects them with flexible experimental methods, the best example of which is his wonderfully innovative idea of using a simple mirror trick as therapeutic measures for patients with phantom limb syndrome.

The book fundamentally dives into the crux of where all our dilemmas arise, our brains. From potential remapping of our neurons, which hold the power to drastically change our perception of reality, to figuring out a primitive visual pathway which doesn't need vision to carry out certain actions, something that might have been referred to as instinct till now, or the bizarre cases of visual hallucinations documented which give rise to further questions

than answers, as great scientific endeavors usually do. Such problems, which were previously cultivated by philosophers, the likes of Immanuel Kant and David Hume, can now be tangibly pursued experimentally. This is essential to the main theme of the book which ties to the Binding Problem of Perception, the neurological equivalent of the Theory of Everything. The binding problem presents the quandary of the Unity of Consciousness: *how does what we perceive connect to all the neural pathways occurring in the brain?* The answer to this question is crucial to the very idea of how our immediate existence is comprehended, as well as a starting point towards pacifying Kant's and Hume's, including today's scientists' pursuit of the solution to the Binding Problem.

Dr. Ramachandran writes in the truly scientific spirit and believes in confronting whatever truths are uncovered while trudging forward with a deductive method of inquiry, even if it implies coming across facts that might just shatter our carefully constructed view of reality thereby providing for us an exciting and provocative read.

Time to look back to see what lies ahead!

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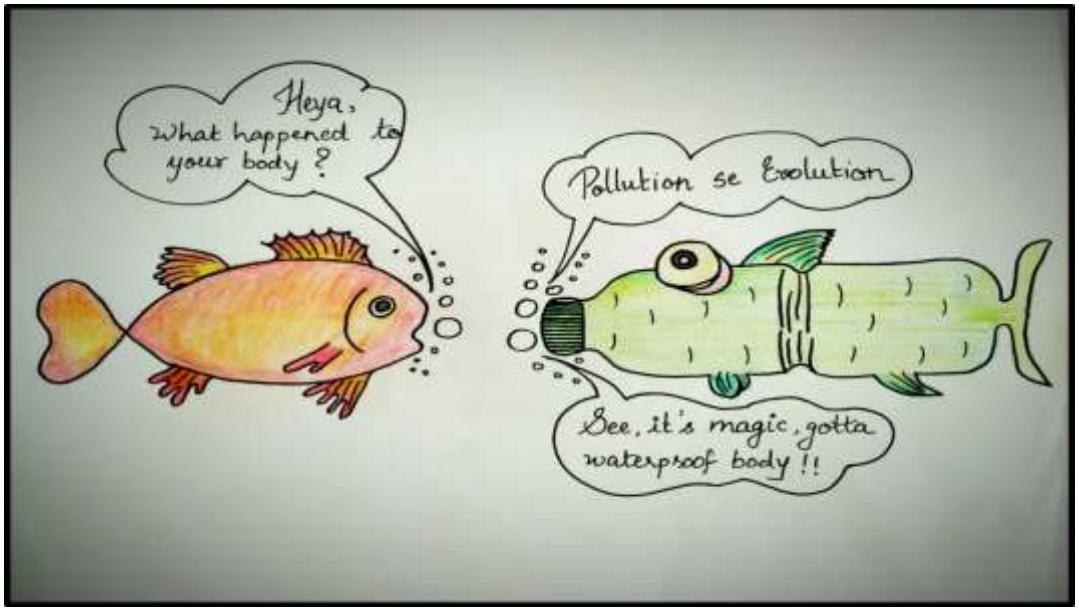
Gone are the days when rising temperature was the only concern due to global warming, over the past decades the effect of global warming is seen in more than just climbing temperature. Since the last century the global temperature has risen by more than 1.6 degrees Fahrenheit, the case is even more sensitive in the abandoned poles in the north and the south. Climate change differs from global warming as it refers to the effect of such changes on the planets weather and climate systems. The effect of which is not only on the global temperature but also is seen in terms of melting glaciers, rising sea levels, shifting wildlife populations and many more global impacts.

There is a relation between these changes and the advancement of the human race, as the latter has harmful effects on the global environment. These changes are emerging due to the continuous and not so gradual addition of greenhouse gases to the atmosphere. Shift in climatic conditions is not a trend of the late 20th or 21st century, past fluctuations like the Ice Age, Medieval Climate Anomaly have also caused changes in the climatic conditions but never has any event had this global reach that affected the planet to such a great extent.
Climatic change brought about by human activities has devastating effects on our planet, the recent outcome of which was seen in Australia. The Australian bushfire event was not long after the world saw the devasting effect of bushfires in the Amazon forest. The worst part about such events is that they are highly predictable and most of them can be controlled to great extends. The Garnaut Climate Change Review published in 2008 predicted the effect climate change would have on Australia, the report also went ahead by stating that the effect of this will be seen in 2020, and that is exactly what the world is witnessing right now. Thousands of wildlife species affected, hundreds of human lives lost and homes destroyed in the recent act of nature seen in the Australian continent (Yu, 2020).

Over the past few decades scientists and climate activists have collected data that show how fire seasons are growing longer which is a direct effect of climate change. This large-scale fire dries the climate furthermore and drier climate in turn increasing burning of fuels which contributes to increasing greenhouse gases being trapped in the atmosphere. But there is a silver lining that is seen with upcoming missions like NISAR and SWOT. The NASA-ISRO Synthetic Aperture Radar, the aim of this mission is to study hazardous and global environmental changes. Data collected through this will help scientists better understand the changing climate and the planets processes, so that measures can be taken to prevent hazardous events in the future.



Credit: Sarangi Bhandarkar
Dept. of Life Sciences

The satellite will collect data of various processes like the ecosystem disturbances, ice-sheet collapse, and natural events of earthquakes, tsunamis, volcanoes and landslides. Surface Water Ocean Topography (SWOT) mission will aid in monitoring local sea level changes at the land-sea interface. This international mission will give us detailed information about a the most important natural resource on planet earth- water. This will help in addressing issues of climate change and help in improving the methods we have been using to use water strategically.

All this information and future directions of research will show results only when people understand the adversity of the climatic conditions and follow the path that leads to development in a sustainable manner. Efforts made on personal levels in order to prevent the rise of global warming will slowly but eventually show worldwide results.

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Ethical wildlife photography

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Wildlife documentation has been an important part of the process of the study of evolutionary sciences, developmental biology, behavioural studies, etc. Earlier documentation of wildlife was done by collecting specimens /sketching the observed organism. After the discovery of capturing a phenomenon through photography, it becomes easier to get fine details with just a click. Photography was just used for clicking pictures of bureaucrats later it was used to capture scenic images and that later on led to capturing wildlife images. Previously not many people used to have the privilege of having cameras so it did not lead to any destruction of wildlife, it was supposed to be a peaceful observation. But lately due to cheaper manufacturing processes everyone can get a camera at a cheaper rate for example cameras such Nikon, Canon which is easily available at rates lower than 5000 rupees. Even you must have at least one person in your friend circle that has camera "DSLR"

Due to an increase in the number of amateur photographers, wildlife photography a peaceful art can now lead to the destruction of wildlife. Lately, there has been a wave of socializing everything on social media to get recognition or become "popular" and everyone is running behind that one perfect click and people can go to any extent to get that perfect picture. A perfect picture can be a timed click or a picture of a rare animal. There have been cases where these photographers have destroyed rare birds' nest so that no one else can capture the image of the rare birds. I have seen before that few people who are neither interested in wildlife nor photography, click pictures because there are several competitions out there that give prize money starting from Rs. 5000 to Rs. 1 lakh. Many photographers tend to use baits for attracting animals. This technique most of the time harms animals because they sometimes tend to generate habit for a portion of easy food and it can also lead to human-animal conflict because of the animal habit of coming closer to humans due to bait technique. As a wildlife photographer and nature lover myself, I try to follow certain rules that help me protect wildlife from excess human interference.

Not harm: Make sure you are not hurting the animal, don't try to attract animals' attention let the go about their business e.g. During my trip to Tadoba Wildlife Sanctuary, we observed Indian rock python resting under the branches, there were few people standing near one of whom threw a stone at the snake just to get its attention. We obviously stopped him but that was just one case, there are many people out there who don't care about the organism.

Keep it natural: Don't use baits or try to make animal habituated to human presence these can later cause human-animal conflict.

Credit: Zeba Madani
Dept. of Life Sciences

Privacy please: While observing snakes, birds' nest, insects, etc. don't move the leaves or branches that cover them this leads them vulnerable to predators.
Maintain distance: Don't try to run behind the animal they are already in stress because of your presence and if you these disturbs them more.
Follow rules: Every region has its own sets of rules regarding wildlife conservation and our protection. Just peek through it before you go to a particular park or sanctuary
Wildlife photography or documentation has helped for the conservation and to spread awareness about thousands of endangered animals out in the wild.

I would just suggest that think from an animal perspective these are just a few pictures to us but for them, it is their life their very existence every action that you take and every single choice of yours can either help in their conservation or can make them cease to exist...
(Note: Few wildlife examples are my personal experiences)

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Autobiography of The Double Helix

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This world wasn't always so stark and sinister. There was a time when there were only four great houses ruling the unproclaimed Kingdoms around the Earth. Our first cousins, 'House Protein' held every region they could get their peptides on. They were the largest, richest and most diverse; thanks to their numerous functions. 'House Carbohydrate' held regions of the Liver and Muscles. Since they needed those areas for their Phosphate manufactory. 'House Lipid' was always in alliance with everyone; since they needed help to run their well established businesses of architecture, communication and storage units. Although they went on to form three smaller houses, the Triglycerols, the Phospholipids and the Sterols, the lipids have always lived as one large family. I, on the other side never felt the need to grow my house. In fact I never felt the need to leave my fort. I am DNA of 'House Nucleic Acid'. I was present when the very first eukaryote walked on, once, unoccupied and unallocated Earth. I witnessed divergence of species and even managed to place my Nucleic Acid members in each of them. Since then I contributed in evolution, because unlike other houses I have the ability to preserve knowledge. I can trace one's entire data, code it and even transfer it.

Even though my presence is so common and essential, I managed to remain undercover for centuries. Many curious humans were trying to find out what is storing and transferring knowledge to new generations even before they were born. The quest was initiated in 1866 when an Augustinian named Gregor Mendel shed the light on how characteristics are passed down to generations. He tried to find the answers by using Pea plants. He understood that there's some factor preserving the traits, which was later labelled as 'genes'.

In Nineteenth century, they found my territory, Nucleus; but I wasn't just concealed in there, I transcended their visual abilities. I entwined myself to thousand times smaller than my size. Hence, no one was able to even look at me for a slight second let alone touch me. Due to this isolation, many humans assumed that House Protein was responsible for genetics since their presence was most common. Finally in 1869, Friedrich Miescher managed to uncover me. He was given a task to isolate and characterize components of White Blood Cells from Pus cells. During the process, Miescher isolated me instead of WBCs. He found my presence very unusual since before him no one had ever managed to do so. Miescher named me 'Nuclein' which later on became my maiden name. He even managed to find what I am made up of, i.e. Hydrogen, Nitrogen, Oxygen and Phosphorus. I must say he was a genius. Also, he determined there was a unique ratio of Nitrogen and Phosphorus. Even though Miescher

found me, he didn't recognize me and went on to believe that Proteins were sole hereditary molecule throughout his life (Dahm, 2005).
Later on, in the twentieth century, scientists focused on me again as hereditary molecule. Phoebus Levene in 1929 isolated 'Ribose', which is the key component of my unidentical twin 'RNA'; the rolling stone of House Nucleic Acid. Although we were never together, he has always been my support system. RNA always multitasked. Even though he remained single in perpetuity; he worked well with other houses in my region. He transcribed my manuscripts and even transported them for me. Phoebus Levene isolated RNA's Ribose in 1919 when we were inside yeast studying fermentation. He found three major components inside us i.e. phosphate, sugar and Nitrogenous base and called it nucleotide. Levene laid the groundwork by stating that each nucleic acid is composed of a series of nucleotide, and that each nucleotide was in turn composed of just one of four nitrogen-containing bases, a sugar molecule, and a phosphate group. Twenty years later, Levene also isolated my sugar component deoxyribose. Although Levene's work wasn't appreciated much, this was bits and pieces scientists would use to understand me completely almost Forty years later.

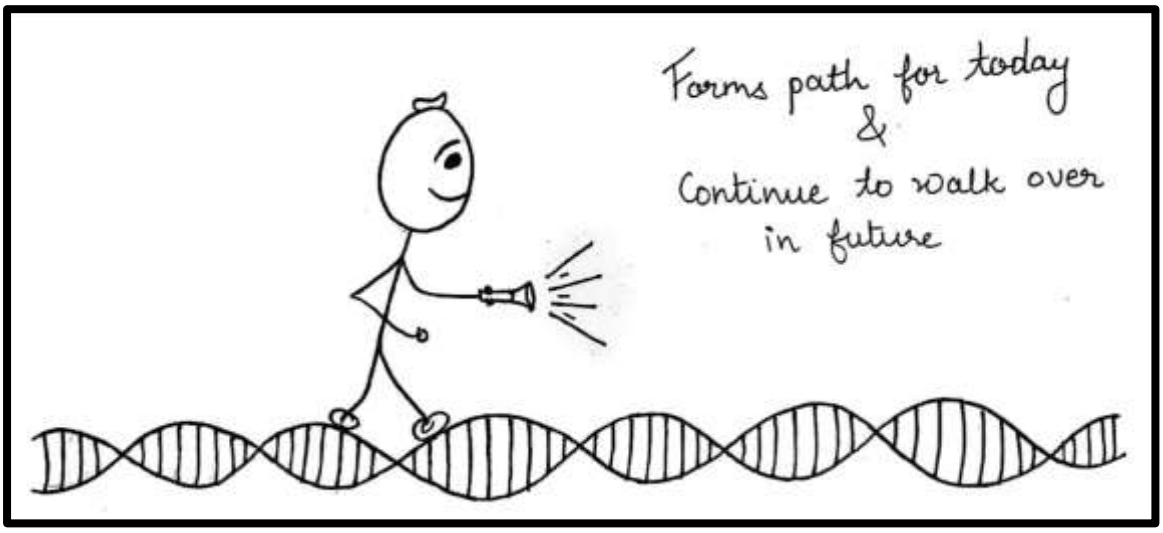
In 1928, Friedrick Griffith was trying to develop a vaccine against *Streptococcus pneumonia.* He injected heat killed virulent and live non-virulent strains in mice. I turned the non-virulent strains to virulent one since I got the codes from heat killed virulent strains. Griffith was surprised when mice died and found traces of live virulent strains in it. He understood that something is responsible behind non-virulent strains taking up the properties of virulent strains even though it was heat killed. Griffith called this process as bacterial transformation or transforming principle. Many researchers found this very interesting and got curious to find the answers. The whole time I sat there and smirked because the answer they were searching was me (Russell, 2009).

During this time, humans had put forth their sentiments of pride and power as most supreme. Instead of identifying themselves by me, humans started identifying each other by flags and hypothetical boundaries. While I was redefined from Nuclein to DNA, they had redefined continents by two deadly world wars. These wicked and savage actions of humans never offended me. But my brother RNA didn't accept this pride and ignorance gently. He called Viruses and started his hunt in their capsids. So in the spring of 1918, the Influenza pandemic spread rapidly all over the world, causing about 20 to 40 million deaths. This casualty was higher than whole WW1 (Beveridge, 1991; Kilbourne 2006).

Since then Earth wasn't same as before. After centuries of colonialism, all ancient houses of Africa went economically poor. Diverse houses of Asia were busy reforming order after years of imperialism. And the rigid rich houses of Middle East were busy securing their oil refineries. So only some Americans and Europeans had curiosity left to continue the quest to decode me. In 1944, Oswald Avery, Colin MacLeod and Maclyn McCarty worked out to

understand Griffith's transforming principle. They began with large amount of heat killed virulent strains and performed series of biochemical tests.The tests gave negative results for protein, hereby ending the debate that molecule behind heredity was House protein, because this purified sample was none other than me, DNA. Avery, Macleod and McCarty confirmed my presence by a chemical test known to detect DNA. They even managed to inhibit my transforming abilities by some enzyme actions (Russell, 2009).

Even though Avery, McLeod and McCarty's work was greeted with scepticism by most geneticists at that time, I caught the attention of Erwin Chargaff; an Astro-Hungarian biochemist, who had earlier been working with House Lipid. Through their work, Chargaff got so motivated that he switched his lab's focus on House Nucleic Acid. He was the first one to question my omnipresence. W wondered whether I was only disguised or truly learned to dissent myself in each species differently. Till then, only I knew the answer but Chargaff unveiled this. In his peojectalong with his colleagues Ernst Vischer and Charlotte Green, I underwent partition chromatography and was even analysed by Ultraviolet Spectrophotometry. I got to experience this process many times because they collected samples of me from multiple species. Thanks to this, Chargaff found my secret to experience life in different species. He found out that my composition varied in different organisms. Also that I always kept members in squad Purine and Pyrimidine equal. He called this 'Chargaff's rule'. Even though my secret was revealed I was astonished by their work. After being analysed by spectrophotometry I wished to be photographed for which I didn't had to wait long.



Credit: Sarangi Bhandarkar
Dept. of Life Sciences

My wish was fulfilled by a lady named Rosalind Franklin, who was an X-ray crystallographer. In 1952, she along with a student named Raymond Gosling captured high resolution picture of me. It was the 51st diffraction photograph Franklin and Gosling had taken so Gosling named that picture "Photo 51". Not only was that a moment of delight for me but also an important hallmark in my journey of unravelling. It wasn't long before my photograph caught attention of scientists. In the same institute where I was photographed worked a Physicist and Molecular biologist Maurice Wilkins. He showed photo 51 to James Watson and Francis Crick, the two scientists who would soon become celebrities of biology and would be praised for decades.

Watson and Crick used previously available information about me and proposed a model explaining my appearance, shape and size. They published their paper in the 'Nature' issue in April 1953. In which they stated, "This structure has two helical chains each coiled around the same axis. We have made the usual chemical assumption, namely that each chain consists of phosphate di-ester groups joining β-D-deoxyribifuranose residue with 3′, 5′ linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fiber axis. Both chains follow right-handed helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions." (Watson, 2003).

There's no doubt that they were correct. Finally I came in front of the world as the basic unit of life, unconcealed and unraveled. At last the world found me and knew that I was driving force behind each and every action they tried to justify throughout history.
I am DNA of House Nucleic Acid and this was the Chronicles of the quest to double helix.

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Immunotherapy - Enhancing Immune Systems for Treatment of Diseases

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Introduction:

In the past decade, the world had witnessed a number of disease outbreaks, dating back to First World War (1918) where Spanish-flu was responsible for nearly 30 million deaths (Johnson *et al.*, 2002). The 1918 outbreak was known to mostly affect the young population thereby affecting the country's economy; which in turn had a profound impact on the medical discoveries as there was a dire need for development of novel drugs (Simonsen, *et al.*, 1998).

The Post World War, therefore, was a crucial period where research in medical field was gaining popularity and this was the beginning of the development of modern medicine (Bynum, *et al.*, 1994). The tremendous efforts carried out in discovering potential drugs and procedures for diagnosis and treatment of diseases during this period, marked a significant decrease in the mortality rates from 1930 to 2005 which was considered as a 'golden era' of antibiotics' (through a survey conducted under 'Global Health Statistical Studies' by World Health Organization) (Druss, *et al.*, 2005). However, the situation changed shortly after a few years in 1940, the excessive utilization of drugs led to addiction and rise in infections caused due to drug resistance where, *Stapylococcus aureus* was found to be the first bacteria to be resistant to penicillin, as it was an antibiotic that was prescribed to treat most infectious diseases. Gradually it gave rise to superbugs (known to have multi-drug resistance) in 1960s, such as methicillin resistant *Stapylococcus aureus* (MRSA) and gentamicin resistant *Enterobacteriaceae spp*. It is predicted that anti-microbial resistance would affect a large population by 2050 where many would succumb to infections caused due to these pathogens (Aslam, 2018; Lee, 2015).

With an aim to reduce the use of drugs for treating infections, scientists began exploring other natural compounds that could be used as a substitute. By 1990 researchers discovered the various applications of traditional medicine and with an aim to promote research in this field, an Office of Alternative Medicine was established within the National Institutes of Health in the U.S. (Benzie, *et al.*, 2007). Alongside traditional medicine, extensive research was carried out in exploiting the products of the immune system for treatment of diseases and this led to the emergence of a new field- 'Immunotherapy'.

Immunotherapy and Cancer:

Although, cases reported related to immunotherapy could be traced back to the late 19th century, it had gained recognition in later years when Dr. William B. Coley published a paper showing that certain bacterial cell components could be utilized to improve the immune response for treatment of sarcoma (Eno, 2017; Zacharski, 2005). Dr. Coley had observed that a patient suffering from recurrence of sarcoma of the neck showed a decrease in the occurrence of the disease when the patient was suffering from erysipelas (streptococcal infection of the skin). He then deliberately introduced streptococcal culture in a patient suffering from inoperable sarcoma of the neck and tonsils. The injections were given in an interval of 3-4 days. The treatment was proved to be effective as he observed improvement within six months where the size of the tumor reduced and the patient showed progress in the voice. Finally, the tumor diminished to an extent where the patient could swallow food and began regaining his health. Dr. Coley's work was a breakthrough in this field which portrayed the importance of immunotherapy in treatment of cancer (Wiemann, *et al.,* 1994; Colev, 1893; Klier, *et al.*, 2012).

Following Dr. Coley's work multiple papers were published that brought light upon the wide applications of immunotherapy in treatment of infectious diseases and cancer. Some of the significant contributions were by Dr. Pramod Shrivastava. Along with his co-workers, they showed that heat shock proteins, which act as chaperones for the uptake of antigenic peptides (which are later processed and presented on the cell surface via MHC molecules) in antigen presenting cells (APCs), could be utilized in improving immune response against cancer. A combination of heat shock proteins 70 (hsp70) with tumor cells was able to develop immunity against the specific tumor cells in mice. His work also showed that the heat shock protein enhanced the immunity only when bound to the antigenic peptide and cannot elicit an immune response by itself. As a result, HSPs have been introduced into vaccines such as OncoPhage (Binder, 2000; Basu, 2000).

Further in 2012, Schreiber et al, demonstrated the various roles of immune systems in cancer, where it in addition to its ability to suppress tumor, the immune system is also found to promote tumor progression by specific selection of cancerous cells that are capable of surviving in an immunocompetent hos and by creating microenvironments that stimulate tumor growth; thus the term 'cancer immunoediting' was introduced. Through their work, it was possible to distinguish between cancer cell and normal cells by identification of the mutated proteins produced by cancer cells. These proteins could be targeted through personalized vaccines termed as neoantigen vaccines. These vaccines can help the immune cells to specifically identify the tumor in the individual's body (Schreiber, *et al.*, 2011; Mittal, *et al.*, 2014).

Immunotherapy in Treatment Of Cancer

Guillaume et al, had worked on utilizing immunotherapy in treatment of infection caused by *Streptococcus suis* serotype 2, a pathogenic-bacteria known to infect pigs (swine pathogen). The bacterium is capsular polysaccharide. They elucidated the protective activity of monoclonal antibodies that are directed against these capsular polysaccharide (CPS) by immunizing mice with CPS of serotype 2 and the cells producing the potential antibodies were selected using hybridoma technology. Two hybridomas were obtained IgG1 and IgM out of which IgM was found to be more effective as it cross-reacted with other serotypes therefore could be used for treating several infections caused by different serotypes of *Streptococcus suis* (Guillaume, *et al.*, 2019).

Conclusion

The immune system is a vital component of the body that is responsible to protect an organism from foreign pathogens. In-depth studies have been conducted over the years to understand its complex mechanism. These mechanisms are now altered to produce cells and antibodies that are capable of targeting and eliminating specific antigens in the body. Immunotherapy has a wide scope in the future for diagnosis and treatment of cancer as well as infectious diseases which could substitute the use of drugs and thereby reducing its side effects.

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Music and Its Applications in Neurosciences

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Music is an art form, it is sound organized in time. While music is most commonly associated with vocal skills, it is also often accompanied with instruments. Studying the bases of cognitive processes and other brain based mechanisms in response to music is what led to the study of neurosciences and music. Musical Memory involves explicit and implicit memory systems. Implicit memory includes inherent memory such as procedural memory and motor skill learning. Explicit memory involves episodic and semantic memory (Baird and Samson 2009). Recognition of musical tones and sense of familiarities is semantic memory. Whereas ability to retrace musical verses or autonomous stating of the next verse is invoked by the episodic memory. Medial and orbital frontal cortex is bilaterally activated by semantic memory whereas middle and superior frontal gyri was activated by episodic memory (Platel, *et al.,* 2003; Kapur, *et al.,* 1995). Memory retention and recall has seen improved by undertaking musical training. Cerebral cortex activation was observed in a group of students that were actively taught and there is greater memory retention (Burriss, and Strickland, 2001).

A study undertaken by Brown, Martinez and Parsons in 2006 compared the neurological implications of language and music. Activation in identical parts of the brain was observed under positron emission tomography when linguistic and melodic phrases were used as stimulus. The stimulated areas include Broca's area, auditory cortices, basal ganglia, primary motor area and a few others. Morphological connections drawn propose that music be considered as one of the ways to incite or kindle the brain function. It is showcased as an efficient non-intrusive method which has garnered attention of experts in the field, but underwhelming practical approach (Brown, *et al.,* 2006).

Research conducted on people with memory ailments like Alzheimer's disease, indicate that memories built and reinforced by music are deeply integrated and hence pose more resistance to stimuli that start or accelerate neurodegeneration. Reports from studies carried out have put forth evidence that suggests rhythmic recreational activities involving motor operations dynamically expedite the recovery of movement in those affected by cerebral palsy, Parkinson's disease, stroke and traumatic brain injury (Thaut, 2005; Maratos, *et al.,* 2008). Parkinson's disease (PD) is one of the convoluted diagnoses regularly linked to motor dysfunction. Therapy includes manifold drug treatments, such as Levadopa, Dopamine agonists and Monoamine oxidase (AlDakheel, 2014). Therapy involving music is an alternative and fairly under-utilized treatment with several advances. Music interacts and

stimulates the regions in the brain which are tasked with assessment and response of behavioral facets of the person such as mood and other cognitive aspects (Grau-Sánchez, *et al.,* 2013; Tsoi, *et al.,* 2018). A network composed of basal ganglia-thalamo-motor cortices and the cerebellar-thalamo-motor cortices is linked with the auditory cortex. Here, basal ganglia-thalamo-motor cortices control the deliberate perception of time intervals and independent movement while cerebellar-thalamo-motor cortices in accurate perception of timing of an event or stimuli, generating and toning motor operations to correspond to the varied auditory cues given off by the stimuli (Bella, *et al.,* 2015).

The result of therapy using music at its core is varied. The outcome on the patients differ amongst them based on the patients' experiences, perceptions, and personality traits. The main function of this therapy is the effect of music on the emotions and response produced in different regions of the brain, primarily, the dopaminergic system. This system has been associated with the feelings of pleasure and contentment produced on exposure to music. Extensive research has also put forth that dopamine is released in larger quantities when the music played is familiar and liked than if it was unalike music (Salimpoor, *et al.,* 2011; Salimpoor, *et al.,* 2015).

Dementia or memory loss is one of the prime symptoms indicating degeneracy of the brain. One of the most common diseases causing dementia is Alzheimer's disease (AD). Other symptoms include decreased cognitive functioning (memory, visuospatial issues, and functioning), emotional control, and neuropsychiatric symptoms such as apathy, depression, and agitation. The degeneration of memory in patients suffering from AD is commonly associated with decreased bodily function and sense of self (Fargeau, *et al.,* 2010). Studies also suggest that music, especially familiar and to the persons (El Haj, *et al.,* 2015) can rouse memories and feelings in patients afflicted from AD (Foster, *et al.,* 2001; Irish, *et al.,* 2006; El Haj, 2012). Further conclusions were drawn suggesting that music therapy could invoke autobiographical memories in the patient and thereby cause an improvement in the patients' conditions especially with regards to cognitive performance, neuropsychiatric functioning and self-consciousness (Arroyo-Anlló, *et al.,* 2013).

Conclusion:

Whilst music was often referred to as form of entertainment or pleasure, there seems to exist a plane where music can actually heal more than just a bout of emotional distress. The implications of music as a form of therapy or part of a palliative care in neurodegenerative diseases is an area of exploration and experimentation. However, with the current data available, it is clear music therapy isn't a one pill fits all. It would require extensive research into the potential patient and collaboration between doctors as well as music experts to design a therapy plan. Despite all its positive properties, music is also known to trigger epilepsy and extensive music therapy may also induce feelings of isolation. The question to ponder upon is if neuronal music therapy is worth the price to pay.

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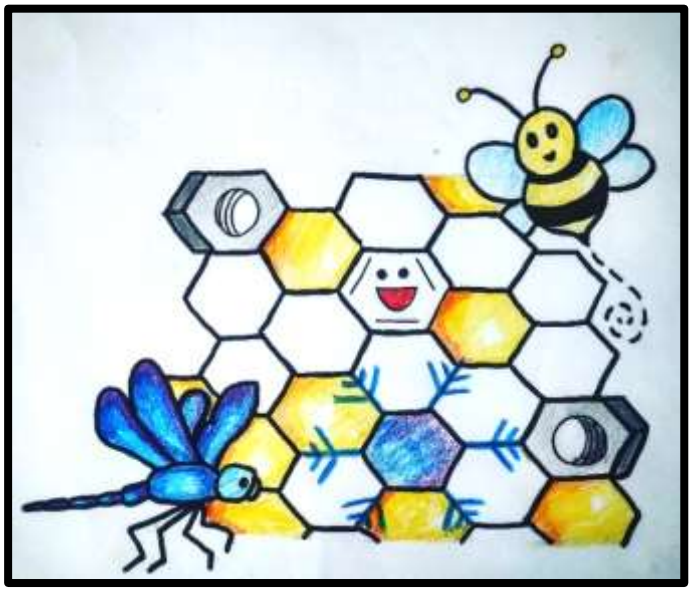
Purposeful Hexagon

Singh Pranali Anil and Roshan D'Souza
Department of Zoology

Let's draw our attention towards this interesting shape which we unfortunately, fail to acknowledge its ubiquitous nature throughout.

We all are fond of nature, aren't we? So, have you ever seen a gorgeous snowflake? Ever wondered why it's hexagonal in shape? Actually, the answer is quite simple. The tiny snowflakes are formed when water droplets present in atmosphere freeze within the mid-air. The rationale behind this particular shape is due to an arrangement of water molecules. These arrangements of water molecules vary with change in temperature.

It's amazing to understand that a lot of living and non-living forms in nature show hexagonal structures. For instance, if we consider the eyes of dragonflies which are made up of 30,000 hexagons which cause the formation of a dynamic system of vision, which is also called Ultra-multicolour system. This is considered to be the best thing ever seen within the whole animal world. Once we compare the human vision and therefore the vision of a dragonfly, the human eye sight has tri-colour vision due to the presence of three types of light-sensitive protein molecule in its eyes. These proteins are known as Opsins. Whereas dragonfly has 30 different types of opsins in its eyes. Hence, the power to differentiate colour is much better in dragonflies than in humans. Here, the question arises ,'How it's possible for a dragonfly to possess 30,000 or more compound eyes?' It is just because of the high packing capability of the hexagonal shape (Futahashi, 2016).



Credit: Sarangi Bhandarkar
Dept. of Life Sciences

Similarly, in case of honeybees as per Marcus Terentius Varro, a Roman Scholar, the deep reason for the honeybees to build the honeycomb having hexagon shaped cells is because it requires less wax and can hold more honey (Nazzi, 2016).

It is seen that biomolecules like Benzene (Heyrovska, 2008), sugar and amino acids and many more such compounds that are made from six carbons, which join with one another to make a hexagonal ring. These hexagonal structures are also present inside our body, some of those are found within the nucleotide bases of the DNA which carries all the Genetic Information (Bari *et al*., 2013).

As we've learnt to imitate nature, Man has created some non-living objects like Nuts and Bolts which have a hexagonal shape. The design of these nuts and bolts has still remained an equivalent since the 1700s. An explanation to the present unchanged shape is that the edges of the tool which grip the bolt, is easier with a hexagonal shape that imparts more force to cause its rotation (Henriksen, 1973).

In a Solar system, except our Mother Planet Earth the second largest planet that is Saturn, ' A ringed planet ' has a persisting hexagonal cloud pattern around its North Pole. This was discovered in the year 1981 during the Voyager Mission and later it had been observed by Cassini - Huygens in the year 2006 (Pryor *et al*., 2019).
Hexagons are often a preferred shape in nature. Even being an unusual shape, it does an excellent job. It is an unique shape which is found within the smallest particle, DNA up to the second largest planet of the solar system whose diameter is 1,20,000 km.

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The Unexpected Visitor - Coronavirus

Muqadas Wani and Michelle Periera
Department of Life Sciences

Coronavirus has been one of the most unexpected guests this year. By making its comeback during the new year it has set a new resolution for us to analyze and understand the virus like never before. The virus isn't a new one in itself and it goes way back wherein it was first identified in Guangdong province of Southern China in 2002. It is said that it was transmitted from bats to civet cats and then to human beings. It was called SARS-CoV outbreak (Severe Acute Respiratory Syndrome). After tackling this virus in 2003, one more outbreak occurred in 2012 which was called MERS-CoV (Middle East Respiratory Syndrome). The causative animal in Middle East was said to be camel meat which was transmitted from bats again. After the end of 2012 outbreak the coronavirus has now emerged again and is known as novel Coronavirus (2019-nCoV) and the first case was reported from Wuhan, China, on 31st December 2019.

Coronavirus is among spherical positive-sense RNA viruses which are distinguished for their club-like spikes projecting out from their surface. This feature gives them the appearance of a solar corona and hence the coronavirus. Within the envelope of the virus it consists of a helically symmetrical nucleocapsid which is uncommon among the positive sense RNA viruses (Fehr *et al.*, 2015).

The patients who were diagnosed with the virus initially complained of shortness of breath. The breathlessness was because this virus directly attacks the intraepithelial cells of lung tissue apart from the throat. The 2019-nCoV causes development of multiple pneumonia and eventually causes lung failure.

Currently there is no anti-viral vaccine for prevention of this virus and the best way to prevent is self-hygiene. This includes, taking necessary measures after visiting overcrowded areas such as washing hands with alcohol-based soaps. One should carry a handkerchief at all times. The consumption of raw or uncooked food should be avoided as much as possible. Most of all, one should consume nutritious food and drink purified water because the virus is known to drastically affect the immunosuppressed. The right preventions taken at the right time will help us sail through 2020 just fine!

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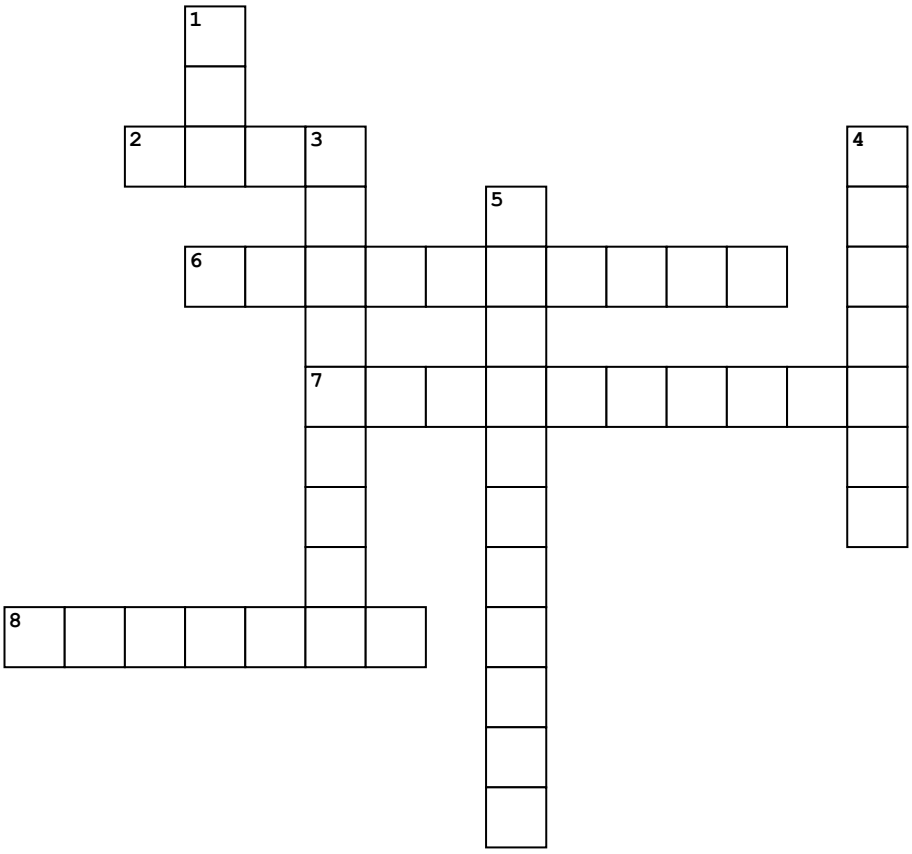
Behavioural Disorders

Chithra C
Department of Life Sciences



Across

2. I should be working, hey! look it's a bird (4)
6. I feel so empty and want to stay in bed (10)
7. Self Obsession (10)
8. Are they talking about me? Do I look ok?? (7)

Down

1. Knock,knock,knock Penny (3)
3. Don't leave me, I need you (9)
4. I should not have eaten all that food (7)
5. Joaquin Phoenix in joker (11)

Whom to blame?

Aiman Naik
Department of Biochemistry

From the plastic wrap of burger,
To the coke we drink,
The plastic keeps on floating,
And of course it sinks.
And we still blame mother earth,
And the angry fire which keeps on rising.

From the building made up high,
To the trees cut down as they die,
We still blame the mother earth,
And the angry fire which keeps on increasing.

From the promises we made to save you,
Till the cut-down forest filled with waste,
And still we blame mother earth,
And the angry fire for never understanding.

From asthma to global warming,
And the pollution-filled planet,
The wish will never come true,
To get back those golden days and a green planet.

From mother earth to the angry fire which keeps rising,
They aren't responsible the thing that are happening,
It's you because of which destruction is taking place,
Because you always learnt to keep on destroying the place.

Green: The chosen one

Melissa Fernandes
Department of Biochemistry

From saplings to trees they grow so soon,
Leaves as their kitchen, stems their store room.
Leaves so green absorb light and prepare food,
Chlorophyll, here, is the cool dude.

But, Why wasn't green the chosen one?
Wasn't any other color the better one?
So here's the story of the seven light brothers,
From violet to red they transitioned their colors.

Violet, Indigo & blue were the cool brothers,
They owned the sky with their vibrant colors.
While yellow, orange & red were the warm brothers,
They made the earth beautiful with their vivid colors.

When the sun, earth & water came together,
Plants were born to Mother Nature.
What would be the best color? They had to decide,
So Mother Nature gave each color a single try.

So violet, indigo & blue absorbed just the red light,
But it wasn't enough for the electrons to go haywire.
While yellow, orange & red did a decent job,
But not enough energy they could absorb.

So Carotenoids & Phycobilins were given their colors,
But, who would rule chlorophyll: the main scholar?

Then Green! Oh Green was too shy to try,
But when it did, it raised the electrons to just the prefect height.
The plants made their own food, what a discovery they made!
They became autotrophic in just a single gaze.

So green was given to chlorophyll, the pigment of the hour,
And from then, it became the plant's superpower.

So now, we know why green was the chosen one,
Because all the other colors were just the accessory ones.

Credit: Sarangi Bhandarkar
Dept. of Life Sciences

Little Warrior

Mehreen Qureshi
Department of Biochemistry

Graphium agamemnon, the tailed jay, is a predominantly green and black tropical butterfly that belongs to the swallowtail family. The butterfly is also called the green-spotted triangle, tailed green jay, or green triangle. It is a common, non-threatened species native to Nepal, India, Sri Lanka through Southeast Asia and Australia. Several geographic races are recognized.

Spread your wings up high in the sky,
Just like if you were this butterfly.
Call it *Graphium ageamemon*
Or green tailed Jay!

It's underside is brown,
It's uperside is black,
With spots of colour green.

Black Hindwings,
With short tails are also seen.
On the inner edge runs two green stripes
Making it look more elegant and bright!

Strong, restless, elegant and bold,
Never does it feel tired and sore

Small and happy it flutters by,
It's colourful wings catch the eye.

Page of Fame

This section provides a list of all the student achievers who have won awards at Inter-college/State/National/ International Research Meetings or students who have cleared National Competitive exams during their tenure as a student at Sophia College.

Undergraduate

Simrah Khan (TYBSc Life Sciences & Biochemistry batch 2017-20) cleared the first round of Aavishkar 2019 and presented at the Zonal level on the topic *'Effect of ethanol on cell death and motor neuron development in Danio rerio'.* (Mentor: Dr. Yasmin Khan)

Ira Pillai (TYBSc Life Sciences batch 2017-20) cleared the first round of Aavishkar 2019 and presented at the Zonal level on the topic '*Role of DHA in hypoxia induced motor impairment in Caenorhabditis elegans'.* (Mentor: Ms. Nabila Sorathia)

Postgraduate

CSIR-UGC NET exam

Saunri Dhodi Lobo (MSc Life Sciences Batch 2018-20) cleared CSIR UGC NET exam (June 2019) in in Life Sciences in the JRF category.

Deepika Jauhar (MSc Life Sciences Batch 2017-19) cleared CSIR UGC NET exam (June 2019) in Life Sciences in the JRF category.

Travel Awards

Avni Rao (MSc Life Sciences batch 2018-20) won Travel Award at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi

Ojal D'Cunha (MSc Life Sciences batch 2018-20) won Travel Award at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi

Beyond the Curriculum: Excellence in Science Program (EXSP) TYBSc Research Projects

Excellence in Science Program (EXSP) was instituted in 1991 with a vision of facilitating the overall development of highly motivated undergraduate science students in the form of scientific presentations (first year), scientific writing (second year) and a research project (third year). This category is a list of students who successfully completed all three years of EXSP and provides titles of their research projects in the third year.

Simrah Khan (TYBSc Life Sciences & Biochemistry batch 2017-20) carried out a research project on the topic *'Effect of ethanol on cell death and motor neuron development in Danio rerio'*. (Mentor: Dr. Yasmin Khan)

Ira Pillai (TYBSc Life Sciences batch 2017-20) carried out a research project on the topic '*Role of DHA in hypoxia induced motor impairment in Caenorhabditis elegans'*. (Mentor: Ms. Nabila Sorathia)

Sanjana Krishnakumar (TYBSc Life Sciences batch 2017-20) carried out a research project on the topic '*A study of the effects of bisphenol A on the social behavior of Drosophila melanogaster'*. (Mentor: Dr. Hema Subramaniam)

Hamnah Ansari, Yashaswini Choudhary (TYBSc Chemistry batch 2017-20) carried out a research project on *'Comparative antioxidant potential of two drought resistant medicinal plants of Rajasthan P.cineraria and C. decidua'* (Mentor: Dr. (Ms.) Prabha Shetty)

Theresa Mary Urumbath (TYBSc Chemistry batch 2017-20) carried out a research project on *'Synthesis of tribromoaniline- A green novel approach'* (Mentor: Dr. (Ms.) Sirisha Murthy)

Priya Karnik (TYBSc Microbiology batch 2017-20) carried out a research project on '*Isolation and identification Bacillus cereus and determination of the antimicrobial spectrum of the bacteriocin like substance produced'* (Mentor: Dr. Gianni Erevelles Mapara)

Presentations at Inter-college/State/National/International level

This section is a list of talented undergraduate and postgraduate students who have represented our College at Intercollege/ National/ International Science Research Meetings.

Undergraduate

Hamnah Ansari, Yashaswini Choudhary (TYBSc Chemistry batch 2017-20) presented at Avishkar 2019 on the topic *'Comparative antioxidant potential of two drought resistant medicinal plants of Rajasthan P.cineraria and C. decidua'* (Mentor: Dr. (Ms.) Prabha Shetty)

Theresa Mary Urumbath (TYBSc Chemistry batch 2017-20) presented at Avishkar 2019 on the topic *'Synthesis of tribromoaniline- A green novel approach'* (Mentor: Dr. (Ms.) Sirisha Murthy)

Simrah Khan (TYBSc Life Sciences batch 2017-20) presented at Avishkar 2019 on the topic *'Effect of ethanol on cell death and motor neuron development in Danio rerio'.* (Mentor: Dr. Yasmin Khan)

Ira Pillai (TYBSc Life Sciences batch 2017-20) presented at Avishkar 2019 on the topic '*Role of DHA in hypoxia induced motor impairment in Caenorhabditis elegans'.* (Mentor: Ms. Nabila Sorathia)

Sanjana Krishnakumar (TYBSc Life Sciences batch 2017-20) presented at Avishkar 2019 on the topic '*A study of the effects of bisphenol A on the social behavior of Drosophila melanogaster'.* (Mentor: Dr. Hema Subramaniam)

Postgraduate

Avni Rao (MSc Life Sciences batch 2018-20), presented a poster on *'Effect of lithium on the expression of siRNA aided silenced NCAM in C6 glioma cells'* at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Yasmin Khan)

Ayushi Nagdev (MSc Life Sciences batch 2018-20), presented a poster on *'Monitoring the effect of metformin on autophagy in Dictyostelium discoideum'* at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Sree Nair)

Binita Vedak (MSc Life Sciences batch 2018-20), presented a poster on '*Effect of premenstrual stress on emotional attention and memory*' at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Hemalatha Ramachandran, Ms. Divya Sinha)

Heenal Panchal (MSc Life Sciences batch 2018-20), presented a poster on '*Study of hypoxia induced cellular damage Caenorhabditis elegans*' at International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Ms. Nabila Sorathia)

Ojal D'Cunha (MSc Life Sciences batch 2018-20), presented a poster on '*Studying biochemical aspects of Drosophila melanogaster parkin mutants and rescue using GLP-1 agonist*' at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Hema Subramaniam)

Saunri Dhodi Lobo (MSc Life Sciences batch 2018-20), presented a poster on '*Assessment of behavioral paradigms for testing Alzheimer's disease model of Drosophila melanogaster GMR Aβ42*' at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Hema Subramaniam)

Vaishnavi Kodakandla (MSc Life Sciences batch 2018-20), presented a poster on '*Effect of timed priming on logo retention and the factors contributing to it*' at 37th International Conference by Indian Academy of Neurosciences, 2019 held at AIIMS, Delhi (Mentor: Dr. Hemalatha Ramachandran)

Iqra Ansari (MSc Life Sciences batch 2018-20), presented a poster on '*Effect of valproic acid on various cellular biological aspects in Hydra polyp*' at National Research Scholar Meet, 2019 held at ACTREC, Navi Mumbai (Mentor: Ms. Aisha Zakaria)

Zufishan Zafar Farhan (MSc Life Sciences batch 2018-20), presented a poster on '*Effect of retinoic acid (RA) on expression of HoxB3a gene during craniofacial development in Zebrafish*' at National Research Scholar Meet, 2019 held at ACTREC, Navi Mumbai (Mentor: Dr. Yasmin Khan)

Biodiversity@Sophia

Pacssiflora racemosa

Passiflora racemosa, also called the red Passion flower, is an evergreen climber to 5m, with 3-lobed leaves and pendent racemes of crimson flowers to 12cm across, with dark purple and white coronal filaments followed by pale green fruits. The pulp surrounding the seeds is edible. Species among the most ornamental of the genus *Passiflora*, vigorous, fast-growing, and with the flowering going on for most of the year, which has originated several hybrids.

- Krishnendu Nair
Dept of Life Sciences

Hypolimnas bolina jacintha

Hypolimnas bolina jacintha or the Oriental Great Eggfly, a member of the Nymphalidae family, is native to the South and Southeast Asia, Australia and New Zealand. It is known for high degree of sexual dimorphism and mimetic behaviour. The male mimics the Danaid Eggfly whereas the female mimics the Common Crow butterfly, a poisonous milkweed butterfly, thus efficiently protecting itself from the predators.

- Zufishan Zafar Farhan
Dept of Life Sciences

Bougainvillea spectabilis

Native to Brazil, Argentina, Peru; this evergreen shrub flourishes in dry conditions, & in fertile soil. Her bracts dressed in vivid pinks or purples and sometimes in oranges or gold, covering her small, white, inconspicuous flowers. Devoid of fragrance, hiding her curved thorns, she is grown as an ornamental plant.

-Heenal Panchal
Dept of Life Sciences

Acraea terpsicore

Tawny coster is a small, leathery-winged butterfly which is mostly seen on *Passiflora* plant species. While observing the lifecycle of Tawny coster, I had captured this picture where a female butterfly has emerged from its chrysalis.

- Bushraa Nirban
Dept of Life Sciences

(Answer key for crossword (page92): 1. OCD 2. ADHD 3. Dependent, 4. Bulimia 5. Psychopathy 6. Depression 7. Narcissism 8. Anxiety)

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