



# OXYGEN

## 2020

The Chemistry Society  
St Stephen's College

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**From the lens of Head of the Department : Dr Shabnam Johry****EMERGING WINNERS IN THE TIMES OF COVID-19**

With the ongoing spread of COVID-19, most of us find our thoughts clouded by fear and anxiety. We feel helpless in the face of this pandemic. The only thing we can do is stay at home, take care of ourselves physically and mentally, and wait for the virus to subside.

Although we cannot deny that the coronavirus and its health risks are real, the fear we're experiencing may be an even more dangerous pandemic. That is why, at this time, it is important to keep our energy positive and our vibrations high. No doubt it is challenging to do so when we are panicking, stocking up groceries, and every news is a warning or update on the pandemic.

Today we need to remind ourselves about the importance of keeping our immune system healthy with the carefully directed energy of our thoughts. Stress and fear-based emotions only serve to lower our immunity and make us more susceptible to sickness. Our thoughts have a strong effect on our immune system. A healthy mind keeps our vibrations high and, therefore, boosts our immunity. Changing our thought patterns can greatly reduce our stress levels. Low vibrational emotions like fear, anger, stress and worry disturb our thoughts and lower our immunity. Creating and maintaining a balance in our body depends on a healthy perspective towards life. This does not mean that we should not feel an appropriate response to what is happening around us. Things may feel scary. Fear is actually our survival mechanism, which helps us to avoid danger, but feeling afraid or anxious does not always help us to survive. Sometimes it makes things worse.

During this period we do not need to be in a constant state of fear. Rather we can rationalize certain things. We can frequently remind ourselves that if we are staying away from others and practising good hygiene we are likely to remain well. Instead of unnecessarily worrying about whether or not we may get sick, we need to tell ourselves that we can control our own health. This will certainly lead us towards positivity and our positive emotions will enhance our immune system. To prevent anxiety we need to do regular exercise, get adequate sleep, drink plenty of water, eat fresh fruits and vegetables, laugh a lot, and eliminate stress agents like constant social media or news updates. Maintaining a healthy mind will have an incredible effect on our psychological, emotional and physical well being, and will automatically boost our immune system.

It is also important to know that within this chaos there lies tremendous opportunity, if we make room for it. In 1665, when the University of Cambridge was closed down because of the Bubonic plague, Issac Newton quarantined himself. This proved to be the most productive time of his life as this was when he developed his theories on calculus, optics and the laws of motion. Let us take this opportunity to bring happiness and positivity back into our lives. Life is so beautiful and special. There are billions of us on this planet, and we all are in this together. There is a benefit this outbreak is giving us — and that is 'unity'. Never before has the world faced such a colossal challenge as one. This could be an opening to rise above fear, and to step up with hope into a higher global consciousness. This could indeed be a wonderful opportunity for us to rise, to elevate and to unify. The Universe surely has a plan for us. Let us fill our hearts with gratitude – gratitude that we have a home, gratitude for the time spent with loved ones, and gratitude for a greater sense of community as we navigate this challenging experience together.

### **From The desk of our Staff Advisor : Dr Violet R Macwan**

It gives me immense pleasure to introduce you to the Annual Journal of Chemistry Society- 'Oxygen 2020'. This journal showcases the young talent of our chemistry students as they have put together the contents on a variety of topics ranging from students' unravelling science through their eyes, research by faculty members, Chemistry Society events of the past academic year and internships experiences of our students at premier institutes of the country.

During these unprecedented and challenging times due to the COVID-19 pandemic, our students have very thoughtfully responded and made three new inclusions to the journal: COVID-19 related articles, poetry by our valuable and deeply appreciated chemistry lab staff, and articles by chemistry alumni sharing glimpses of their life at college.

In the academic year 2019-20, the Chemistry Society students have been very active in organizing and participating in the Inaugural lecture, Borosil workshop, commemoration of International Year of Periodic Table, and various inter-college events and competitions.

I express my heartfelt appreciation to all the office bearers and volunteers for their enthusiasm and commitment. However, in March 2020 as the University of Delhi was closed due to COVID-19 pandemic, activities of the society came to a sudden halt and all interactions transitioned to the virtual mode. Event cancellations and delays became inevitable. Yet, the members of the Editorial Board of Oxygen 2020 have relentlessly worked together to bring out this issue of the journal.

I sincerely appreciate and thank all the contributors, editors, designers and photographers for giving their valuable time, effort and creativity for the publication. We are also very grateful to our Principal, Prof. John Varghese and Head of the Department, Dr. Shabnam Johry for their constant support and encouragement.

I wish you find reading Oxygen 2020 both interesting and enjoyable !

## **Foreword by the Editor in Chief of Oxygen 2020 : Vaibhav Khanna**

As I am moving forward and my college life is nearing completion, it has made me think about the beautiful journey I have undertaken in these three years. Although there are several milestones that I have achieved, being the Chief Editor of the annual journal of the Chemistry Society, Oxygen, tops the others significantly. My profound relationship with the journal began from the orientation of the Chemistry Society in my first year. I was extremely excited to be a part of a society that would not only supplement my education but also help me develop holistically. Our seniors introduced us to the several events that the society takes pride in organising. I was drawn to all activities and events but the annual journal Oxygen seemed the most intriguing and promising to me.

Being associated with the society for three consecutive years has made me realise the importance of teamwork and cooperation. I have worked with both my juniors and seniors. It was by the virtue of constant guidance from my seniors during my first and second year that I could effectively guide my juniors and motivate them so as to ensure that as many students contributed to the journal. I also feel that it is because of the relentless efforts from every senior member of the Chemistry Department that all of us have been able to transcend beyond our limits and have contributed to the journal. I would also like to express my gratitude towards our staff advisor, Dr. Violet Rajeshwari Macwan for her constant guidance throughout the year and for motivating us to ensure we all give our best shot and contribute to the journal.

I congratulate all the members of the society who have worked tirelessly and have taken Oxygen to a new level. It was amazing to work with a vibrant team and to have endless learning opportunities while being on this journey.



## **Insights of the President, The Chemistry Society : Pempa Tshering Bhutia**

I remember getting an earful of scolding after the society's orientation for not paying attention. It wasn't a pretty sight but it motivated me to take society seriously and work harder. I haven't stopped ever since. Be it making posters for publicity or working for logistics, inviting professors for a talk or checking the room's availability for the same, I have come a long way.

I always felt safe and in a protected space within the society, it felt home. Teachers to support and seniors to guide, I couldn't ask for anything better. ChemSoc has taught me leadership, organisational skills and the spirit of teamwork. It always feels happy to sleep after pulling off an event successfully. But, to pull off an event takes prior planning, task allotment and work in action, which I have learnt from the society down these years.

I was to attend the first talk of the society when my senior had told us, "Don't expect to understand the talk for more than 5 minutes". It indeed turned out to be true. I couldn't understand it any further. It was then I realised through ChemSoc what field I am in and how I grasp it from a scientist's point of view.

Being a part of ChemSoc, I have made myself a small family. It feels wonderful when my friends come and help us in decoration and organising events like freshers' welcome or farewell (even if they aren't a part of the council). One thing that I would miss the most is Dr. Shabnam's life lessons and inspiring talks. I always looked forward to her speech at such events. I could hear her for like forever!

Three years have passed by really swiftly. Now, when I see juniors taking over us, I feel both happy and sad. Happy, because the society is in safe hands and sad because I doubt if I would ever get a chance to work in such a beautiful family cum society. I always felt proud to be a Stephanian but now I realise that it was more because I am a product of the Chemistry Department, St. Stephen's College.

As I go, I want you all to believe in the power of dreams! Once you have dreamt about it and given your best shot, no one can take you away from changing your dreams to reality. Even if it doesn't work out, don't feel afraid to stand up again and work for it, if you fall, stand yet again! You would succeed then.

## **Insights of the Vice President, The Chemistry Society : Aiwin Abraham**

Look straight ahead and fix your eyes on what lies before you. Mark out a straight path for your feet. Stay on the safe path, don't get side-tracked – Proverbs 4:25-27 (from the Holy Bible)

There is an age-old saying which goes like, “You can predict what one will become based on the path one treads”. Paths that we choose sure give essence to what we ought to become. The very reason we are here, at this very moment, is all because of the many choices we made at different crossroads that we encountered. Each path is of importance as it has some lessons to teach us. Here at St. Stephen's we have our paths intertwined, so also being here at Stephens is one of the many roads that we are yet to discover. Like every turn in the road has something new to reveal, so in every new phase of our life, we are faced with new sets of challenges but remember it also comes with an opportunity to help us learn something new. Learning is a process that we will never get done with as there's always something new. Learning and growing go hand in hand. Believe me, when I say, this space will bring out the better you only if you allow. There's no holding back to it now. It is these extra-curricular society activities along with the curricular ones that give a sound performance to a student. I still remember how as a first-year I was asked to do the logistic works carrying chairs from one location to another along with other technical work and even got yelling from seniors at the various events but there's something more to it, through these society activities you learn the life lessons of confidence, teamwork, and interpersonal skills. The Chemistry Society functions throughout the year conducting events that include Keynote Addresses, Intra and Inter College Paper Presentations, National Conferences, Charusita Memorial lecture, Resonance, and many new events yet to unveil.

The very pillar of support of our society is our teachers. Our society has been blessed with the best we could get. It is because of their support and zeal that the functioning of the society goes unhindered. We are fortunate to have our H.O.D Dr. Shabnam Johry ma'am inspiring us to smile and be persistent with our work. We are also honoured to be led under the able guidance and supervision of our staff advisors Dr.Rakhi ma'am (2017-2019) and Dr.Violet ma'am (2019-20). They have always been a constant source of motivation, helping us to push our limits and make the mark. Their contribution to the society is unquantifiable.

So, it comes down to which path you want. Know that if you are waiting for the time when you will do things perfectly, you'll never get things done. In times of test let us not forget the path or question the journey we have made this far. Rather believe in the higher power who brought us here. Life is the only teacher who takes the test first, so always keep a discerning mind to what it teaches at every turn or it will keep taking surprise tests until you learn it well. It is eventually you that matters so ‘live as if you were to die tomorrow and learn as if you were to live forever’. Passing on the baton to the next capable hands, I on behalf of the entire executive council of 2019-2020 wish the upcoming councils all the best.



## STUDENTS : UNRAVELLING SCIENCE

### AUTISM SPECTRUM DISORDER

“Why fit in when you were born to stand out?”

By Anuska Chakraborti, B.Sc(H) Chemistry, II Year

Autism or autism spectrum disorder (ASD) is a broad and complex neurodevelopmental disorder. Interestingly, ASD does not refer to a single condition. Each person with autism has a different set of symptoms with different severity. Nowadays, ASD is an umbrella term for several conditions which used to be diagnosed separately: autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS) and Asperger's Syndrome.

According to Diagnostic and Statistical Manual of Mental Disorders (DSM-5), ASD is characterised by “Difficulty with communication and interaction with other people, restricted interests and repetitive behaviours and symptoms that hurt the person's ability to function properly in school, work, and other areas of life.” Thus, symptoms can be categorized under two heads: social interaction behaviours and restrictive behaviours.

Social communication behaviours of people with ASD consist of many things. They tend to make little eye contact and often do not listen to people. They may be slow to respond to someone calling their names or trying to gain their attention. Back and forth conversations are difficult for these people. They tend to hold lengthy one-sided conversations about topics of their interest while failing to notice other's disinterest or their attempts to contribute to the conversation. Many times, they find it difficult to understand other people's perspective and predict their actions.

Restrictive behaviour may include repeating certain behaviours or having unusual behaviours like having overly focused interests such as moving objects or parts of objects. Changes in routine upset them. One of the most common symptoms is enhanced or diminished sensitivity to sensory input like light, noise, clothing or temperature. People with ASD are often plagued by insomnia, irritability etc. Though people diagnosed with ASD are faced with great difficulties in day to day life, they are endowed with many strengths as well. They often have a high intelligence quotient. They can learn things in detail, are strong visual and auditory learners and are said to have savant-like memory. It is wrong to assume that all autistic people behave the same. Each individual's symptoms vary in severity. Some may require significant support in their daily lives while many others are high-functioning.

Behavioural and other physical handicaps aside, ASD has a huge psychological impact on the patients and their families. Diagnosis is often met with denial, anger and sadness. And then starts the blame-game. In the last couple of decades, research in this field has seen immense progress. Whereas earlier, the mother would have suffered the blame, nowadays it is proven that autism has its roots in genetics. Some environmental factors, such as conditions after fertilisation and complications during birth may also be held responsible. However, the exact genetics and neurochemistry of this disorder are yet to be known.

We are easily able to understand social cues. It does not matter to us whether we are having parathas at 9:00 am on Mondays or cornflakes. However, as depicted by the symptoms above, an autistic person faces difficulties in everyday activities that a neurotypical individual takes for granted. On top of that, they are forced to camouflage themselves because society is unaccepting of the so-called 'abnormal'.

Autistic children, in many instances, face emotional and sometimes physical abuse in their homes because of the ignorance of parents and siblings as well as societal pressure to be 'normal'. Diagnosed children recurrently face bullying in schools and among their peers. Bullies are primarily born of fear of the unknown and these children, with their 'peculiar' behaviour, provide an easy target for them to lash out at. Furthermore, many autistic children have great learning capabilities and are extraordinarily proficient in subjects of their interest which may make it easier for them to grasp what is being taught in classes. This creates resentment among their peers. The inability of some of these children to pay attention to what others are saying often lead to teachers labelling them as troublemakers. Also, their sensitivity to sensory input can lead to everyday classroom and playground noises becoming magnified to intolerable levels. This adversely impacts their ability to concentrate in classrooms and to socialise with others, further increasing a sense of being different.

A lot of autistic adults face problems while trying to get a job. It is because the employers often lack knowledge of ASD or may have misconceived notions of the disorder which make them feel they may have to make a large number of changes to facilitate the autistic employee. However, they fail to grasp that the autistic person can contribute as much as a neurotypical individual if not more. Obsessive attention to detail characterises a lot of autistics. Some see it as a handicap but it can also ensure a job well done. Prejudices and ignorance among the neurotypicals tend to ramp up the anxieties of an autistic person, which makes it difficult for them to socialise in and out of their workplaces.

It is because of these reasons that the prevalence of comorbid mental health conditions with autism is strikingly high. Children often internalise their negative feelings which arise due to mistreatment and isolation in early stages of life, especially in schools and sometimes even at their own homes. This may lead to feelings of inadequacy and lack of self-worth. A need to fit in gives birth to anxiety issues and stress. Unemployment of adults is a reason for their poor quality of life. Thus, autistic people are at a high risk of depression, self-injury and suicidality. Even their families face quite a number of difficulties. The parents of such children are at a high risk of "under- or unemployment, financial stress, family burden, poor health-related quality of life, worse physical and mental health, and poorer psychological well-being." The main causative factors are, again, the cookie-cutter approach of our society and the lack of a proper and economical health care system for people diagnosed with ASD.

Autism acceptance is important for an autistic individual's mental health. It can be defined as "an individual feeling accepted or appreciated as an autistic person with his autism positively recognised and accepted by others and the self as an integral part of the individual." Teachers and students alike should be made aware of this disorder and its nuances. Schools should be made in a friendly place for autistics. Spreading awareness is the first step to generating tolerance and acceptance to all that is different. Furthermore, health care facilities need to be

made accessible and economical. This puts less strain on the parents which in turn improves the environment at home for the children. Also, early diagnosis lessens the difficulties faced by a child by providing early treatment and therapy to help him cope with day to day life.

Lastly, we would do well to remember that normality is quite overrated. Lewis Carrol, Albert Einstein, Isaac Newton, Mozart and Michelangelo are some of the well-known historical figures who were supposedly autistic. It was the round pegs in square holes that thought the unthinkable and looked where we are now because of them! As Albert Einstein said it succinctly, "Everybody is a genius but if you judge a fish by its inability to climb a tree, it will live its entire life believing it's stupid."

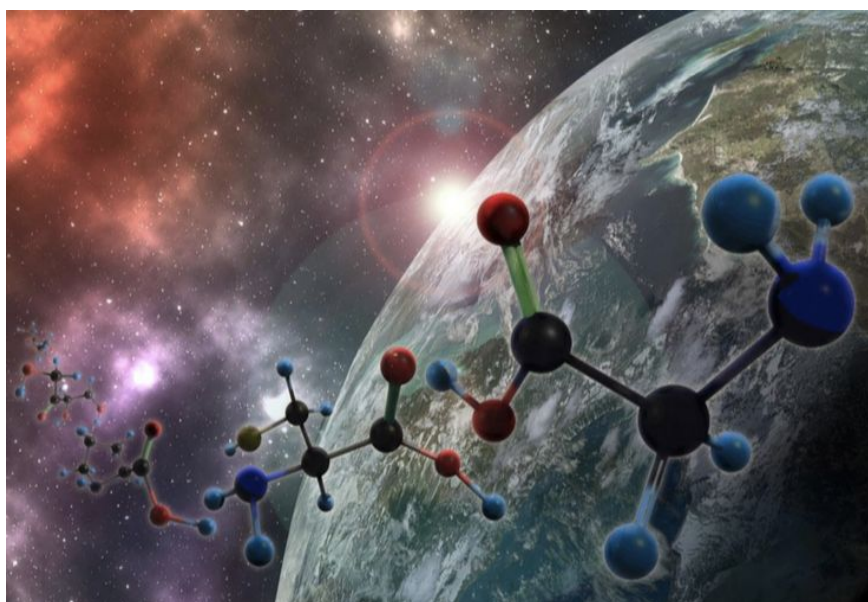
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**ASTROCHEMISTRY - THE CHEMISTRY OF COSMOS.**

By Mukund Sharma, B.Sc(H) Chemistry, I Year

Recently, a planet named K2-18b made it to the international headlines. The data from Hubble revealed the presence of water vapour in the atmosphere of this earth-like planet. This team of scientists consisted of astronomers and astrochemists from University College, London. What's so special about this planet is that it lies in the habitable zone of its star and the discovery of water molecules in the atmosphere of an Earth-like planet is potentially an indication that we are not alone in this universe! All this was possible because of these astrochemists and astronomers. This discovery has ignited the minds of many in the field of astrochemistry. One can define Astrochemistry as "the study of cosmic phenomena based on intermolecular interactions and interaction of molecules with Radiations." According to Wikipedia, "The study of the abundance of elements and isotope ratios in Solar System objects, such as meteorites, is also called "cosmochemistry" and "The study of interstellar atoms and molecules and their interaction with radiation is sometimes called molecular astrophysics".



The formation, chemical composition, evolution and fate of molecular gas clouds are of special interest because it is from these clouds that solar systems form and ultimately it is in these solar systems that we are looking for a potentially habitable planet (or planet B). Spectroscopy which is an essential technique employed by chemists is also equally vital for astrochemists. Until 1930, it was assumed that all the chemical species that occur in space were atomic. However, subsequent discoveries like that of Formaldehyde and Carbon monoxide in the atmosphere of other planets have made it clear that this is not the case. Astrochemists make use of spectroscopy to analyse the absorption and emission of light from molecules in interstellar environments and then compare astronomical observations with laboratory data so that they can infer the abundance of elements and chemical composition and other conditions prevalent in the said environment.

Radio astronomy is an equally important branch of astronomy, which has been advantageous in the detection of interstellar chemical species. One of the most common molecules in the interstellar space, Carbon monoxide was discovered using radio astronomy. It is so common that now it is also used to map out the molecular regions. This technique involves the use of a

radio telescope. Wavelengths from astronomical sources are intercepted and then they are analysed. Usually, scientists look for repetition of patterns in the plot of the radio signal because that gives them to an extent, the idea of what this astronomical object is. For example, pulsars were discovered when Jocelyn Bell Burnell observed pulses separated by 1.33 seconds that originated from the same location in the sky, and kept to sidereal time. The short period of the pulses eliminated the possibility that radiation sources were astrophysical (i.e. Stars). Also, since the pulses were kept in sidereal time, they couldn't be artificial or human-made radio frequency interference. Similar observations were obtained with another telescope and confirmed the emission. Although the idea that signals were extraterrestrial crossed the minds of Bell Burnell however, they didn't have any strong evidence suggesting that radio emissions were entirely natural. Bell is puzzled by the problem of how can anyone announce the results responsibly if they have detected life elsewhere in the universe. Bell Burnell and Antony Hewish nicknamed the signal LGM-1, as 'little green men' (a playful name for intelligent beings of extraterrestrial origin). However, these detection techniques have their limitations as well. To understand them one may consider the example of hydrogen, which is unarguably the most abundant element in the universe. Radio Astronomy has a limitation that it cannot detect a molecule without a dipole and also the one that isn't in a gaseous phase. Therefore, till date, this technique has not been able to detect hydrogen molecules even in the regions where there is a high density of hydrogen molecules. As a result, it has to be detected using other wavelengths of light.

Recently, many interesting discoveries have been made in astrochemistry. These include the detection of Helium hydride ions in the interstellar space and glycolaldehyde in a distant star system. Helium hydride ion ( $\text{HeH}^+$ ) is the lightest heteronuclear ion and is believed to be the first ion formed right after the big bang. Although stable, it is highly reactive and cannot be prepared in bulk, as it could react with any other molecule with which it comes into contact. It is often noted as the strongest known acid and its occurrence has been conjectured since the 1970s. Formation of helium hydride can occur in the cooling gas in dissociative shocks in dense interstellar clouds. Such dissociative shocks can be caused by stellar winds, supernovae and outflowing material from young stars. For the first time in the world, on 29th August 2012 astronomers of Copenhagen University identified a specific sugar, glycolaldehyde in the star system 400 light-years away from the Earth in protostellar binary IRAS 16293-2422.

Glycolaldehyde is vital for catalytic synthesis of D-ribose. This discovery indicates the formation of organic molecules in stellar systems before the formation of young planets. It illustrates the importance of astrochemistry in the study of the evolution of the universe. In India, astrochemical research is in its early stages but many foreign universities like the University of Illinois offer doctoral programmes in astrochemistry. One can be sure to see this exciting new field grow in years to come. Discoveries in the field of astrochemistry will continue to help scientists understand the nature of this peculiar universe.

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**WATER :A HEALER***"Water is the driver of nature" - Leonardo da Vinci*

by Mridul Krishna Sharma, B.Sc(H) Chemistry, Ist Year

Water is a pivotal component of our abiotic ecosystem. Being oblivious to the medicinal chemistry behind this resource, we often take it lightly as a simple liquid for quenching our thirst. Here I would like to make you aware of the medicative power of water. Surface tension has immense application in our lives, be it in working of pens, action of detergents, soaps & paints etc. Normal tap water has surface tension of around 72-73 dyne/cm and varies with temperature and other factors, but generally it remains 73dyne/cm. Our body has to reduce the surface tension of water to 45dyne/cm so as to allow water to penetrate through human cells. Once it gets into the cells it removes toxins from them by hydrating the cells and makes the cells healthy. If water doesn't penetrate inside the cells then it can lead to dead cells that can also cause development of cancer cells. As we know that with lowering of temperature, surface tension increases that mean drinking cold water will require more work to make it suitable for cells for osmosis. Not every time will the body be able to do this extra work.

Water forms a number of clusters of H<sub>2</sub>O molecules (due to surface tension). Usual tap water contains up to 13 large clusters of water molecules so they don't get absorbed easily but the water (micro clustered ionized water) with 5-6 smaller clusters of water which can be absorbed easily, are more permeable and make the hydration process faster. Due to sufficient amounts of water our body will absorb essential nutrients and minerals more rapidly. The high permeability of water hydrates our body in seconds and prevents Bloating. Cold water has more clusters of water than normal water. Hence it is not fruitful for us to drink cold water. On the other hand, warm water can be effectively used for the purpose of better digestion and detoxification according to Ayurveda (as I believe Ayurveda is now most popular in curing diseases from roots), Because body doesn't extra effort in reducing its surface tension to an optimal range. When we drink cold water our body will not feel the need of drinking water for a long time, but our body needs a sufficiently large amount of water for its functioning. So, when you're thirsty it is a better choice to drink warm or normal water than cold coffee, tasty tea or sugar drink. Water is your better option year-round

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**ARE ANTS STEALING OUR NAIL CLIPPINGS?**

by Twinkle Kelkar, B.Sc(H) Chemistry, Ist Year

Ants are sweet and harmless little creatures until you do not bother them. But they bother us at any moment, believe me! Usually I am not a good observer, if you ask my Mom she'll tell you how I keep asking her for things that are accidentally in front of my eyes. But a short time ago, I made an observation. Yes, an observation, because of which this article of mine came to exist. One fine sunny day, I was cutting my fingernails and I saw one of the ants

stealing my nail clipping and carrying it to its small peculiar home. I mean, dear ant, it was good when you were stealing sugar crystals from my home but clippings of fingernails, I did not expect. Literally, it does not suit your sweet character.

This shocking observation forced me to find out more about this incident. I was astonished to find out that similar incidents had been reported from all over the world on the internet. Every coin has two sides and so does this observation. One theory says that ants are attracted to the smell of food present in our nails. And that the dead skin cells and bacteria under our nails also lure ants to carry them to their homes. But, you would be amazed to know that ants cannot eat our nail clippings. So what do they do with them? Our nails are made up of this protein called keratin. There are nutrients in proteins, however, to emphasize, keratin is notoriously difficult to digest and ants cannot digest it.

Another theory draws our attention to the point that ants are fungus farmers. And fungus can digest keratin. So it is possible that ants are placing nail clippings on fungus which is getting energy from it and benefitting ants as well (symbiotic relationship). But fungus-growing ants are only found in the Western Hemisphere, USA and Argentina and such happenings are observed all across the globe making this all the more riveting. The answer to the question of what ants do with the nail clippings is still unexplored. They might be digesting keratin or there is some process which is alien to us. This article may not reveal the science behind it but it reveals the truth about life. And the truth is that nature is the art of God and thus, it is supreme. Nothing compares to nature and it is always beyond our imagination. Thus we should keep on moving because there will always be so much to discover about nature and about ourselves.

“In all things of nature, there is something of the marvelous” - Aristotle

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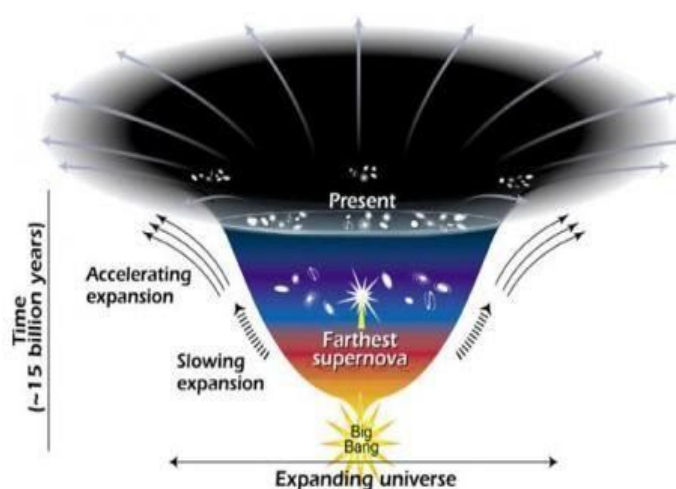
## **DARK ENERGY**

by Deepti Nehra, B.Sc(H) Chemistry, 1st year

In 1998, the Hubble Space Telescope (HST) observations of very distant Supernovae revealed that, a long time ago, the Universe expanded at a very gradual rate, contrary to the present. Hence, the expansion of the Universe has not been slowing down due to gravity, which was initially thought so by everyone. Instead, it has been accelerating. This was expected by none, and scientists were unable to find an explanation for it. But something was causing it. Eventually theorists came up with different sorts of explanations. Although theorists still don't know what the correct explanation is, they have given the possible reason a name. It is called “DARK ENERGY”.

In physical cosmology and astronomy, Dark Energy is an unknown form of energy which is hypothesized to permeate all of space, thereby accelerating the expansion of the Universe. Dark Energy contributes 68% of total energy in the present day observable Universe. The nature of Dark Energy is more hypothetical than that of Dark Matter and many things about it remain in the realm of speculation. Dark Energy is thought to be very homogeneous and not





very dense and it is not known to interact through any of the fundamental forces other than gravity. Since it is quite rarefied and un-massive, roughly  $10^{-27}$  kg/m, it is unlikely to be detected in laboratory experiments. The reason Dark Energy can have such a profound effect on the Universe (it makes up 68% of the Universal density despite being so dilute), is that it uniformly fills the otherwise empty spaces. The evidence for Dark Energy, although indirect, comes from three independent sources:

- Distance measurements and their relation to redshift, which suggest the Universe has expanded more in the last half of its life.
- The theoretical need for a type of additional energy that is not matter or Dark Matter, to form the observationally flat Universe.
- Measures of large- scale wave patterns of mass density in the Universe.

There are a number of ongoing programs aimed at discovering more about Dark Energy. Whatever may be the source of Dark Energy, it is clear that the Universe is affected by things that scientists cannot conventionally observe.

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#### Image Reference-

[https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Dark\\_Energy.jpg/220px-Dark\\_Energy.jpg](https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Dark_Energy.jpg/220px-Dark_Energy.jpg)

## CHEMISTRY AND APPLICATIONS OF BIOLUMINESCENCE

by Diksha Dewan, B.Sc(H) Chemistry, 1st year

Nature is mesmerizing. Often it displays such phenomena that capture our memory forever. Indeed the view of a glowing beach and our shining footprints is so breathtaking that it seems as if the stars have come down to grace the ocean with their presence. And today we know that this glorious phenomenon is “Bioluminescence”. Bioluminescence refers to the production and emission of light by a living organism as the result of a chemical reaction, during which chemical energy gets converted into light energy.

It is codified as “cold light” which means that less than 20% of the light produces thermal

radiation. Approximately 76% of ocean animals are bioluminescent such as sharks, anglerfish, squids, etc. Besides these, some terrestrial organisms like fireflies, railroad worms also glow. Just as this phenomenon, the chemistry behind Bioluminescence is all the more fascinating. This generally happens as a result of oxygenation reactions i.e. Oxygen reacts with 'Luciferins' and light is generated as a form of energy. The catalysts employed in these reactions are called 'luciferases' and the products formed are 'oxyluciferin'. Due to the presence of different luciferins in different species, chemically different oxyluciferin are produced.

Bioluminescence is not just a natural phenomenon but is a concept that is constantly employed in various applications. Today we have environmental biosensors that are developed using various bioluminescent microscopic organisms and can assess the degradation of water, soil, air, etc. This field is undergoing great research. For instance, this could help light streets and highways. This would reduce the need for electricity. Someday even, bioluminescent crops could inform the farmers about the need for water and nutrients. How cool it would look when plants would develop red colour to alert the farmers as an early warning about maladies. Undoubtedly, Bioluminescence, albeit a less known fact these days, will soon illuminate almost every aspect of our lives.

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## FORMATION OF PEARLS

By Ridhima Raina, B.Sc(H) Chemistry, 1st Year

The "Queen of Jewels" (as it's typically stated as), pearls possess an unchanged quality and it's continuing to charm individuals from the time it absolutely was first discovered till nowadays. Aside from its beauty that catches the world's attention, the formation of pearls in itself is a thing to be fascinated from. Pearls are literally a product of an organic process, oysters' means of protecting itself from foreign materials.

But before beginning to understand the formation of pearls, it is important to be familiar with the anatomy of oysters. Oysters are bivalves i.e. its shell is made of parts or valves which are held together by elastic ligaments. Oysters have different parts in its shell, like palps(mouth), intestine, heart, mantle etc. As the oysters grow, their shell grows. The mantle is the organ which is responsible for the building of oyster's shell from minerals derived from food. Mantle produces a substance known as nacre which forms the inner linings of oyster shells. Pearl formation takes place when a foreign entity such as a grain of dust or a parasite enters between oysters' shell and mantle. In order to protect itself from foreign material, the mantle covers the irritant with the same nacre. Layers of this nacre eventually lead to the formation of a pearl.

Cultured pearls are also prepared in the same manner with the only difference that the irritant is deliberately induced into the oyster's shell by a pearl farmer. In 1878, Japanese

entrepreneur Kokichi Mikimoto was the first person to produce a round, artificial pearl. Oysters are not the only molluscs producing pearls. Clams and mussels also produce them. Pearls acquire different colours from their source of origin. In between layers of the oyster's inside-shell and nacre are layers of organic "glue" called conchiolin. Conchiolin has a natural pigmentation that seems as blue, grey, yellow, green, pink or orange hues. These colours are then absorbed into the surface of the pearl. Thus we see pearls in a variety of colours.

If talking regarding conchiolin, it's a fibrous protein that forms the iridescent inner layer, as nacre, within the shells of molluscs. Conchiolin is a complex protein which is secreted by a mollusc's outer epithelium. These proteins are a part of a matrix of organic macromolecules, in the main proteins and polysaccharides, that are assembled along from the microenvironment wherever crystals nucleate and grow. This organic matrix conjointly holds and binds to the crystals of aragonite that offer such shells their stiffness. Conchiolin is a comparatively versatile, crack-deflecting matrix for the mineral combination particles; its strength and also the sturdy bonding of perlucin will in some cases offer the finished material a powerful level of toughness.

It is interesting to note that pearl is the only mineral that is obtained from living creatures. They are an incredibly rare occurrence in nature and it is estimated that only 1 in 10,000 oysters(or even less) bear economically productive pearls. Today, the most expensive pearl costs \$100 million. Measuring in at 26 inches long and weighing nearly 75 pounds, it is the largest pearl that is known to exist.

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### **The 2012 Nobel Prize in Physiology or Medicine**

By Disha Kashyap, B.Sc(H) Chemistry, II Year

Genes contain the blueprint of life. "The genome is only a mirror for the breadth or narrowness of human imagination. "Omnis *cellula e cellula*- all life has arisen from pre-existing cells, and existing cells can only create like cells. Cells were believed to have predestined fates, and once they travelled down that path there was no return. Dr. Shinya Yamanaka and Sir John B. Gurdon heralded a medical revolution, and shaped the course of biological research when they reprogrammed adult cells to behave like embryonic ones.

Each cell of the body has a lineage- a story that unfolds as it ages. This story is recorded in its genome, in its proteins, on its cell membranes in the form of chemical markers. Theoretically, it is possible to trace back each cell of the adult human body to its time of conception. The cell's fate is decided, however, based on complex interactions of several parameters such as genes, environmental influences, stages of development, cell signalling, etc.

The fusion of a sperm and ovum gives rise to a zygote- the first cell of human existence. Upon further cell division, the zygote gives rise to the embryo. At this stage, each cell has a blank slate. Termed as an embryonic stem cell, its infinite plasticity or ability to differentiate into any cell of the body is characteristic. Embryonic cells are said to be pluripotent- they possess the ability to give rise to any lineage or family of cells: blood, neural, immune, muscle, etc. As the cell progresses through a particular lineage, all other options are considered to be closed. The cell is now said to be multipotent- it possesses the ability to give rise to any cell within a particular lineage. For example, if the embryonic cell differentiates into the immune cell lineage, it can further differentiate only to give rise to white blood cells, neutrophils, macrophages, etc. and not neurons or cardiac cells. These binaries of cell identity were considered to be absolute but it's key to remember that the human mind and imagination don't conform to boundaries.

In 1962, Sir John B. Gurdon was able to prove that the differentiation of cells is not permanent. By replacing the nucleus of the ovum or egg cell of a frog with the nucleus of a mature intestinal cell, he demonstrated that the DNA of a mature cell possessed all the requisite information for the development of frog. This immature egg cell with the nucleus of a mature cell developed in a normal tadpole. The second breakthrough that followed was the actual reprogramming of a mice-derived adult skin cell by Dr. Shinya Yamanaka. By using a cocktail of only 4 genes: *Oct3/4*, *Sox2*, *Klf4* and *c-Myc*, Dr. Yamanaka had returned the adult skin cells to their embryonic state.

These induced pluripotent stem cells or iPSCs ushered in a new era of personalised medicine and regenerative therapy. Researchers could now derive cells from a patient's skin, blood or any other cell, reprogram them into iPSCs, and finally, use them to grow cells of any kind: liver cells, neurons, cardiac cells, etc. These cells would be at the beck and call of doctors for treating disease. This type of therapy comes under personalised medicine because one's own cells were being used to heal oneself circumventing almost entirely the risk of immune rejection. This was a case of regenerative medicine because it involved the use of regenerating cells, and entire tissues. Such therapy also managed to sidestep the ethical opposition faced by umbilical cord-blood derived embryonic stem cells or those derived directly from embryos.

Apart from therapy, iPSCs have played an instrumental role in disease modelling and investigating mechanisms behind diseases. For example, Dr. Ming and her team used iPSCs to create brain organoids or mini brains- 3D portions of tissue that resemble developing organs. Upon exposure to the Zika virus, it was revealed that the pathogen attacks the neural stem cells leading to a decrease of the volume of the layer of neurons resembling microcephaly or a smaller than usual brain-size. Invaluable for treating degenerative disorders that result in a loss of the affected cells, scientists have obtained cells from the skin or blood of patients suffering from neurological disorders such as Alzheimer's, Parkinson's, Huntington's etc. and reprogrammed them to give iPSCs. These cells are then directed to differentiate into the cell types that are malfunctioning, and examined thoroughly to reveal insights about the molecular mechanisms of the disease. These cells have also been used for screening or testing of experimental drugs that may cause harmful side effects. While such testing is not entirely conclusive, it helps in a less costly and more efficient selection of drug candidates, and reveals important information for the second line of experimentation.

The recent pandemic of Covid19 has shown us a mirror to our inability at combating and preventing disease effectively. The time and age we live in demands the need for ecosystems

of support between governments, researchers, and pharmaceutical companies. We must always remember that determined scientific enquiry and the interminable human spirit make the most potent combination possible.

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### **The Nobel Prize in Chemistry 2015**

By Seerat Sekhon, B.Sc(H) Chemistry, II Year

The DNA molecule, demonstrated as the material of heredity in 1944 by Oswald Avery, was considered to be stable and resilient till the 1960s. It was thought that if genetic information was too unstable, no multicellular organisms would have existed and henceforth, in spite of the times genetic material has been copied, the most recent copy should be similar to the one that was created in the fertilised egg. This was considered to be one of the vital displays of biologically active molecules. But, from a chemical perspective, all chemical processes are prone to random errors & consistent flow of genetic information with a limited number of mutations per generation sounds impossible. While addressing the proposed stability of DNA molecules in the late 1960s, Tomas Lindahl started working on RNA molecules. In one of his experiments, he heated RNA & was amazed by its rate of decomposition on heating. He questioned the lifetime stability of DNA molecules when they are exposed to several carcinogenic substances each day.

The incompatibility of the frequency of potentially devastating injuries to the genome every day with human existence on Earth made them search for existing molecular repair systems for DNA defects. This realisation opened the door for an entirely new field of research & 2015 Nobel Prize in Chemistry was awarded to three pioneering scientists who mapped the molecular function of these DNA repair systems -Tomas Lindahl, Paul Modrich and Aziz Sancar.

The base excision repair mechanism formulated by Tomas Lindahl was a result of his experimental observation that even in the absence of external physical assaults, DNA can undergo many chemical reactions which he termed as DNA Decay & includes reactions such as hydrolytic deamination, oxidation and non-enzymatic methylation. He demonstrated that

under physiological conditions, the spontaneous occurrence of cytosine deamination leads to the formation of uracil. This makes cytosine deamination a highly mutagenic process as the formed uracil can form base pairs with adenine & poses a risk of depleting the genetic material. He proposed spontaneous hydrolytic DNA depurination which could stimulate cleavage of DNA chains, facilitating the release of uracil as a free base from DNA identified uracil-DNA Glycolase.

However, The repair mechanism for damaged DNA by environmental assaults was yet to be addressed. It was mapped by Aziz Sancar in the 1970s as “nucleotide excision repair” (NER). The realisation of the biological effect of UV radiation in the 1960s, which involved the introduction of thymine dimers in damaged DNA & concomitantly, inactivation of DNA translation and transcription, led to the study of precise molecular consequences of thymine dimers and how cells deal with them. The seminal discovery of 1964 showed that thymine dimers appeared only in low molecular weight fractions & disappeared from the irradiated, high molecular weight genomic DNA shortly after the UV exposure. This result was correctly interpreted as thymine dimers being excised (removed) from the DNA, hence the name excision repair was thought.

To confirm that interpretation, Sancar identified, isolated and characterised the enzymes coded by the genes *uvrA*, *uvrB* and *uvrC* in UV-sensitive strains of bacteria, while studying repair mechanisms in dark. In ground-breaking in vitro experiments, he showed that these enzymes could identify a UV-damage & then made one incision on each side of the DNA damaged part, thereby, removing a fragment of 12-13 nucleotides containing the injury. The study of NER mechanisms in mammalian cells showed their close relation to the ones found in bacteria. However, the damage recognition and dual incision are carried out only by three proteins in *E. coli*, more than fifteen proteins in human cells to carry out the same function. While wondering about the erroneous DNA replication machinery, Modrich wondered that there was always a possibility for the introduction of an incorrect nucleotide during the synthesis of a new DNA strand. This would result in a non-Watson-Crick base pair, which would distort the double-stranded DNA helix. These types of errors can change the sequence of DNA causing mutations.

He analysed the DNA's structure & realised that methyl groups coupled to DNA can function as signposts by facilitating a particular restriction enzyme to cut the DNA strand at the correct location, such that the mismatch is removed. Therefore, the enzyme DAM methylase which can couple methyl groups to DNA shaped his research interests. The development of assays focussed on the analysis of DNA mismatch repair in cell-free *E. coli* extracts & mammalian cells showed that DNA methylation does not direct strand-specific DNA repair in eukaryotic cells, in contrast to those found in *E. coli*. It was concluded that DNA mismatch repair is a natural process that corrects mismatches in DNA via recognition of the defected strand in its unmethylated state. Besides base excision repair, nucleotide excision repair, and mismatch repair, several other mechanisms that maintain our DNA & fix thousands of occurrences of

DNA damage caused by the sun, cigarette smoke or other genotoxic substances. If just one of these components fails, the genetic information will change rapidly, leading to an increase in cancer risks. For instance, congenital damage to the nucleotide excision repair process causes xeroderma pigmentosum, which makes human DNA extremely sensitive to UV radiation such that skin cancer can develop even on slightest exposure to the sun.

In fact, in many forms of cancer, these repair mechanisms are affected, increasing the instability of the cancer cells' DNA. This is one reason why cancer cells often mutate and become resistant to chemotherapy. At the same time, these infected cells are even more dependent on the repair systems that are still functioning. Without these, their DNA will become too damaged and the cells will die. Researchers are attempting to utilise this weakness of cancer cells in the development of new cancer drugs. A pharmaceutical called olaparib has tried to inhibit the remaining repair system in cancer cells, which results in slowing down or complete inhibition of cancer growth. In conclusion, the basic research carried out by the 2015 Nobel Laureates in Chemistry has not only deepened our knowledge of how we function, but could also lead to the development of novel treatments. In the words of Paul Modrich: "That is why curiosity-based research is so important. You never know where it is going to lead"

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## Research by Faculty Members

### Science on the Caravan

By Dr S V Eswaran, Former HOD (St Stephen' College)  
Adjunct Prof. (Hony.), Deakin University, Australia

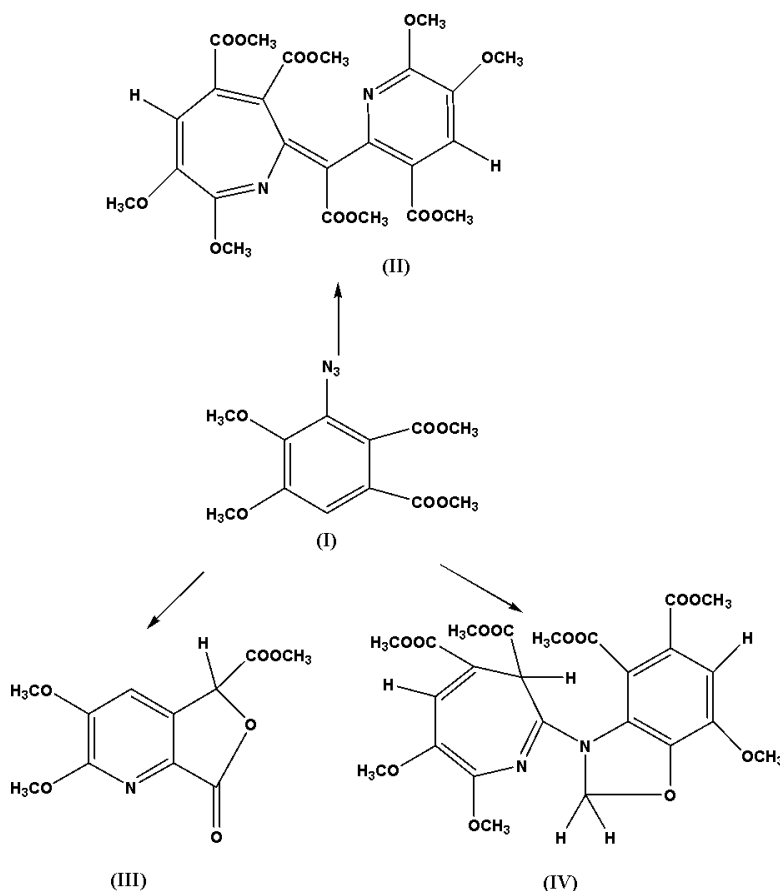
During 1968-2012, I taught at college and received many prestigious teaching awards. In 1984, the Faculty of Science University of Delhi recognized me as the sole Ph. D. supervisor, while working in college. This was indeed a singular achievement. I could thus do my experimental research work in college and produced seven Ph. D.'s from the science block with all the limitations of space and funds. Post my retirement, end of June 2012, I served for two years as CSIR Emeritus Scientist in college. It was since then that I had to do my science literally on the move. Undoubtedly, it has been very challenging. Each time I had to move my laboratory to a new place, and restart doing experimental work, with no funds and with little or no manpower. But at the end the science that happened on the Caravan has been phenomenal. But, surprisingly this period has led to a large number of research papers in major international peer reviewed journals. It must be pointed out that it involved building collaborations both nationally and internationally. This essay is addressed to the genuine students of science and to make it available to students at large.

The essay covers the new compounds discovered by me, which include "Viswamayene" & "Fullarazirman". In addition, the use of the combined technique of 'chemical crosslinking-mass spectrometry-bioinformatics' with implications for "Cataractogenesis" and photo-microlithography for making the microchips are also discussed.

#### 1. "Viswamayene" (I) and its analogs:

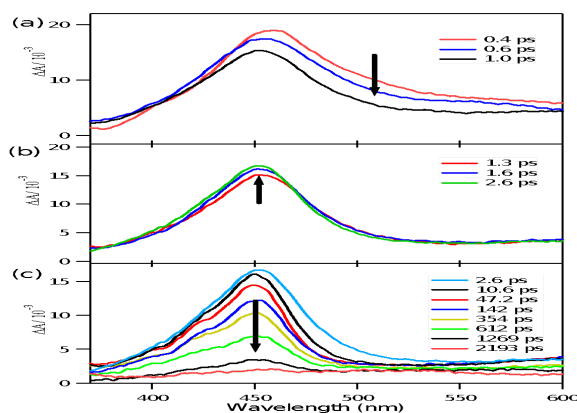
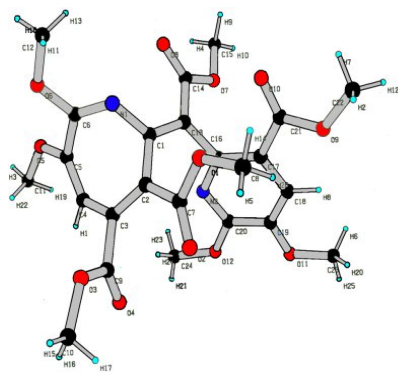
Thermolysis of 'azido-meta-hemipinate' (I) led to the title compound, "Viswamayene" (II) <sup>1</sup>, <sup>2</sup>. The compound is named in honor of Prof M. A. Viswamitra, IISc, Bangalore in whose laboratory the X-ray diffraction work was carried out (shown below). He was a student of the Nobel laureate, Prof Dorothy Crowfoot Hodgkin, who said, "Viswamitra has green fingers"- i. e. whatever he touches he crystallizes. The formation of this new compound involves a series of rather involved rearrangement reactions leading to a concomitant ring expansion and a ring extrusion reaction. Initially, the azide loses nitrogen yielding a singlet nitrene, which would generally get converted into the corresponding triplet nitrene, which would show blue fluorescence for the amine formed from it, which was not observed in our case at all. Thus it was hypothesized that the singlet nitrene in our case was a 'long-lived' transient and in the absence of a nucleophile got converted into "Viswamayene". It should be noted that the aromatic ring in the starting material has given way to a seven membered azaheptafulvalene ring in (II), along with the formation of a pyridine ring due to an extrusion reaction. The latter must involve a carbene, formed from the initial nitrene intermediate which in turn is formed by the loss of a nitrogen molecule from the azide.

In addition to formation of **(II)**, two more compounds were also isolated from this reaction mixture. Compound **(III)** is clearly a product based on carbene insertion, the carbene arising out of a nitrene-carbene conversion. Nitrene-carbene conversion (Crow Wentrup pathway) though known is very rare. The current work is the only one of its kind from the whole of India. A nitrene insertion into the adjacent ortho-methoxy group leading to the benzoxazole **(IV)**.



**(I):** ‘Azido-m-hemipinate’ **(II)** “Viswamayene” **(III)** A pyridylcarbene insertion product  
**(IV)** A nitrene insertion into the adjacent methoxy group.

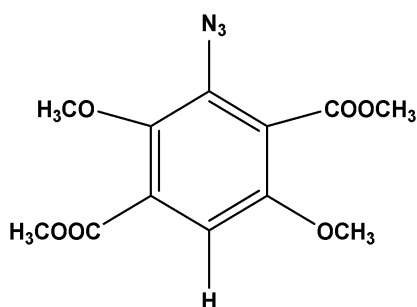
That ‘long-lived’ transients are indeed involved, was subsequently proved at the Ohio State University, Columbus, OH, USA by transient UV-visible fast spectroscopy, which confirmed the life span of the transient to be 700 ps **(V)**-‘long-lived’, indeed!<sup>3</sup> Note that I made meta-hemipinic acid in the summer of 1984 in Heidelberg, Germany and the initial experiments began during my visit to the OSU in 1997, the work being published in the Journal of Physical Chemistry in 2012! These results were also confirmed by computational work using Gaussian 09 software which also established that the singlet nitrene gets converted via the benzazirine, heterocumulene intermediates and then into the corresponding carbene intermediate, which in fact is more stable by about 6 KCal./ mole.



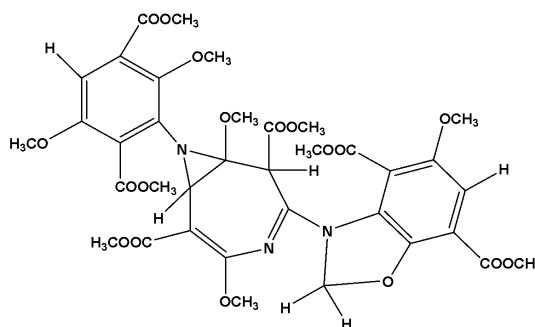
(II): “Viswamayene” hemipinate’

(V): Transient UV-Vis fast spectroscopy (on azido-m-

A question was raised, whether the observation would also be in the corresponding para analog? Hence azido-dimethyl succinylosuccinate (VI) was prepared in college and subjected to thermolysis and as expected it gave similar results. Thus among other compounds, compound (VI) was characterized from the rather complex mixture.<sup>4</sup>(VII) contains two aromatic rings, a three membered aziridine ring, a seven membered azaheptadiene ring and finally a five membered oxazole ring, all made in the Science block (campus) of our college. Does it not make you feel proud?

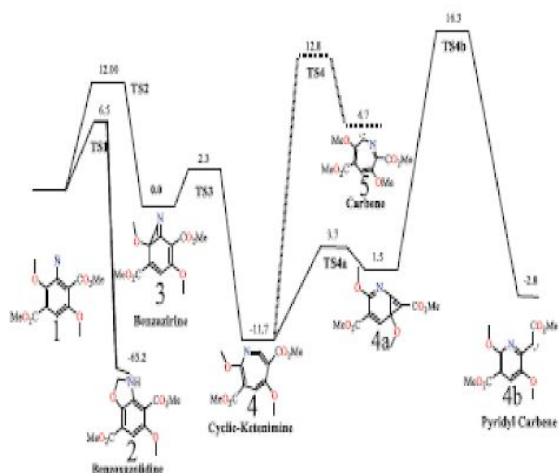


(VI)

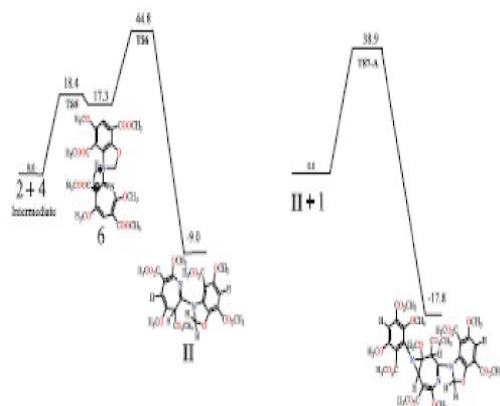


(VII)

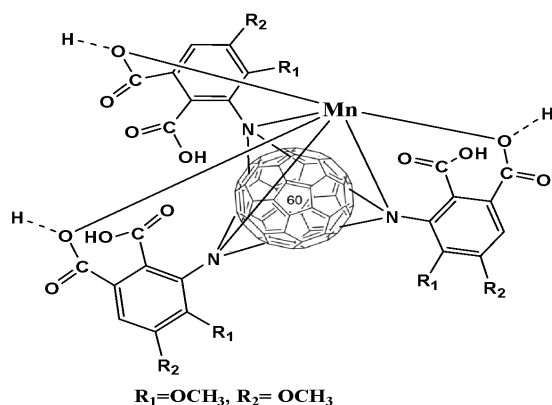
(VI): Azido-dimethyl succinylosuccinate (VII): Thermolysis product of Azido-dimethyl succinylosuccinate



Dr Biswajit Ganguly's group in Bhavnagar did the calculation of the relative energies of the different Transition states and the intermediates involved (VIII) in the formation of (VII)

**(VIII): Energies of the transition states and intermediates involved in formation of (VII)**

Ms Meenal Jain, a third year student from college came two years ago to work with me for a month. She used the Schrodinger software suite to do ADMET studies on partially saturated analogs of “Viswamayene” and showed that some of these showed up to 79% similarity to antivirals like Tenovir and Acyclovir. At that time there was no COVID-19 crisis. After successfully completing her M. Sc. at IIT, Kanpur she has been offered admission to four major American Universities.

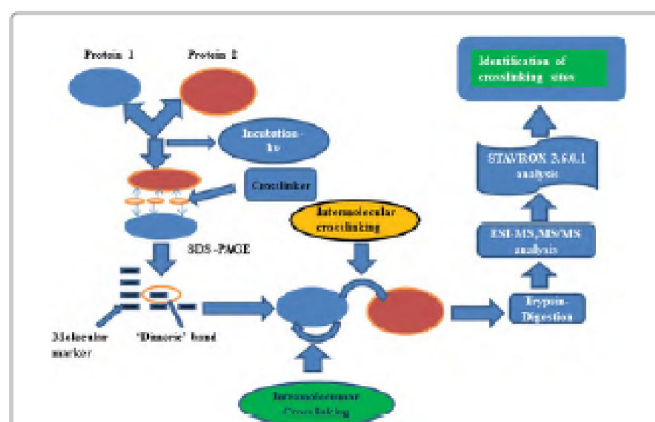
**I. “Fullarazirman” (IX)**

Nanocarbon materials (Fullerene C<sub>60</sub>, Carbon nanotubes, CNTs and Graphene) are much discussed allotropes of carbon. However, their large scale industrial use is hampered by their poor or low solubility in most common solvents. Water soluble nanocarbon materials have suddenly raised hopes in this regard<sup>5</sup>. Buckminsterfullerene C<sub>60</sub> was heated with such an azide when the water soluble “Fullarazirman” (IX)<sup>6, 7</sup> [Fullerene aryl aziridine Man (II) complex] was obtained most unexpectedly. It was characterized using

many modern techniques but MALDI-MS and ESR spectroscopy need to be specially mentioned. It was shown to possess anti-cancer activity comparable to that of Doxorubicin, currently the most commonly used anti-cancer drug, which suffers from many side-effects, chiefly cardiotoxicity. Fullerenes are known to moderate this side effect of Doxorubicin.

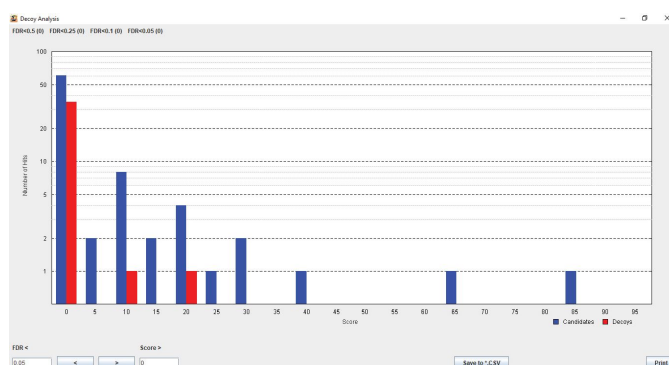
**II. Cataractogenesis:**

The above azides led me to prepare new heterobifunctional crosslinkers for studying protein-protein interactions using the new combined technique of ‘Chemical crosslinking-mass spectrometry-bioinformatics’. The protocol (X) involves incubating the two proteins together with the crosslinker, followed by photolysis, SDS-PAGE, excision of the ‘dimeric’ band, trypsin digestion, zip-tip, mass spectrometry (preferably ESI-MS), MS/MS (‘tandem MS’), combining all the data into a dot (.) mgf file and then uploading into a bioinformatics software along with the FASTA sequences of the two proteins (we used StavroX 3.6.0.1), when the software automatically identifies the crosslinks and gives molecular masses up to the fourth decimal place.



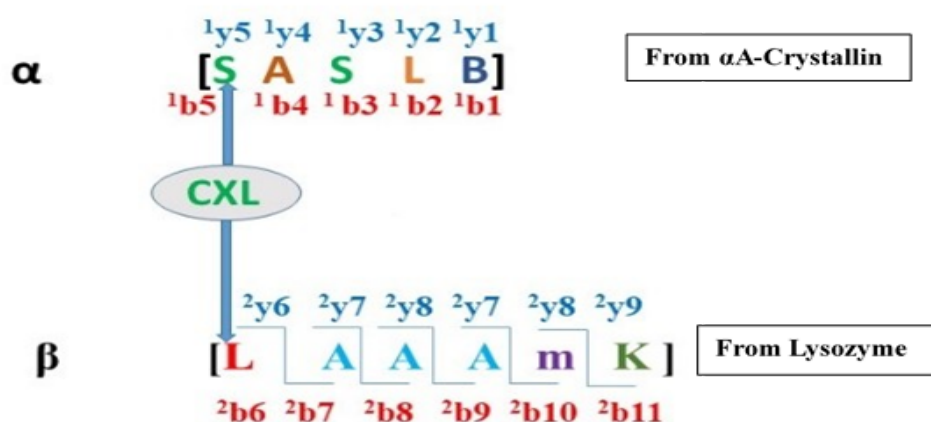
(X): The flow sheet/ protocol used for Chemical crosslinking of two different proteins

The output from the software is DECOY analysis diagram (XI), obtained when the software compares the experimental data from the original FASTA sequence fed with the 'false' reverse sequence. The larger number and intensity of the blue bars compared to the red bars indicates greater successful crosslinking.



(XI): DECOY analysis of the crosslinking of Lysozyme and  $\alpha$ A-Crystallin

Among the different studies we undertook studies on crosslinking of Lysozyme (11 kDa) and  $\alpha$ A-Crystallin (19kDa) are highlighted here. Both these proteins are found in the human eye though separately. Lysozyme is found in human tears, while  $\alpha$ A-Crystallin is the major protein of the human eye lens. This protein is water soluble, heat stable and 100% transparent. When it degrades, crosslinks, it becomes translucent, cloudy and finally opaque leading to Cataract which causes 60% of blindness in the world. Using the above protocol, this is the first such result<sup>8</sup> reported by us in literature and has implications in understanding the origin of Cataract (Cataractogenesis) the intermolecular crosslinking sites in the peptide fragments m/z 1290.597 along with the 'b' and 'y' ions obtained from the StavroX 3.6.0.1 software, showed that it consisted of the  $\alpha$ -fragment coming from  $\alpha$ A-Crystallin, while the  $\beta$ -fragment coming from Lysozyme (XII). Very recently, it has been shown that a part of the amino acid sequence of  $\alpha$ A-Crystallin controls the overall status of the human immune system. The human eye is thus 'the window to the world' but also protects us from infections!



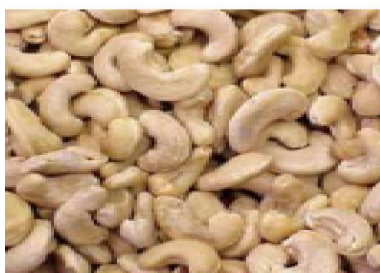
(XII): Crosslinking sites between αA-Crystallin and Lysozyme

**III. Cashew Nut Shell Liquid (CNSL) and Microelectronics:**

The azides discussed above have been successfully used by us to print microelectronic circuits on silicon wafers leading to the microchip. The aryl azides were blended with Novolac resins made from Cardanol, a constituent of CNSL, spin coated on silicon wafers, exposed to UV light of appropriate wavelength and developed. Further steps of etching and standard microelectronic device preparation protocols yield the microchip for use in building any microelectronic devices, e. g. mobiles, cameras, television, laptops, etc. <sup>9, 10, 11</sup>.



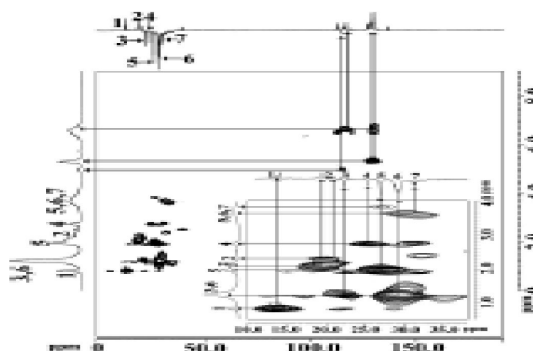
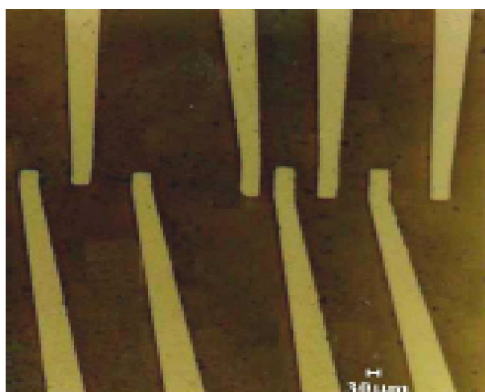
(XIII): The Cashew fruit (CNSL)



(XIV): Cashew Nut



XV: Cashew Nut Shell Liquid



**(XVI)** Photomicrolithographic pattern printed **(XVII):** 2D-NMR spectrum of a photoresist on a silicon wafer

We published a very large number of papers on this subject and have been granted an Indian patent in 2010 and assigned to DRDO, Govt. of India.

The young reader is cautioned that this article is only a curtain raiser and only by reading the literature in the references cited below can one obtain a deeper understanding of the topics covered here. My essays on Grasshoppers have not been covered here (*Resonance*, **2009**, 978-982 & **2013**, 18, 810-816). In the scenario of COVID-19, it may be a good idea to read my article entitled, 'Glycans-The Third Alphabets of Life.' During December, 1989, students of the second year class working after college hours prepared in three steps 125 grams of an azide carrying out bromination, nitration and displacement reaction. Almost all the students who took part are today Professors/ Scientists in major academic/ industrial centers in U. S. A., Britain and Europe. Can the college department with so much manpower in terms of teachers, students and laboratory staff not produce intermediates, say for the pharmaceutical and polymer industry?

### Conclusion:

Four major titles have been covered in this article. The new molecule "Viswamayene" was discovered in college and its formation is most unusual and involved 'long-lived' transients (life span 700 ps!). It involves a nitrene-carbene conversion, as shown by the formation of both nitrene and carbene insertion products in the same reaction. This fundamental phenomenon observed in college has led to many practical applications. "Fullarazirman" was thus prepared and shown to possess anti-cancer activity comparable to that of Doxorubicin, currently the most commonly used anti-cancer drug with many side effects, particularly cardiotoxicity. "Fullarazirman" has been patented by us and the new nano-preparation of ours can moderate the undesirable side effects of Doxorubicin. This in turn led to studies on the origin of diseases, e. g. origin of cataract (Cataractogenesis). A polymer prepared from Cashew Nut Shell Liquid (CNSL) blended with the photosensitive aryl azides led to photoresists for photomicrolithography, the work horses of the burgeoning multi-billion microelectronic industry, leading to microchips used in building most common microelectronic gadgets.

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## Taste the Sweetness!

By Dr. Jyotirmoy Maity, Faculty, St Stephen's College

Gustation refers to the act of tasting when we experience a food or drink by the taste buds located on the front and back of the tongue and on the side, back and upper portion of the mouth. These taste buds are collection of 150-300 tightly packed gustatory receptor cells of epithelial origin and these taste cells are of four different types, *i.e.* type I (glial like cells/ absorb neurotransmitter), type II (receptor cells), type III (presynaptic cells), type IV (progenitor / basal cells). When we intake a food or beverage, the molecules from food / drinks get dissolved in saliva and bind with the taste receptors who send the signals to the brain. Our brain perceives these stimuli in five basic tastes, *i.e.* sweet, salty, bitter, sour and umami. In addition, lipid sensors present on the tongue suggests that fat could also be considered as sixth taste. Due to this limitation of the number of basic tastes, we rely on our sense of smell to judge the quality of food or drink through the realm of flavour. It is a complex assessment of food and drink that comes about when our brain melds together information from our different senses.

Sweet, umami and low concentration of sodium in the food depict the nutrient value of the food. Bitter, sour and high concentration of sodium perceives the presence of toxin, freshness / spoilage and presence of high quantity of minerals, respectively in the food. Creamy sensation describes the consistency and presence of high content of fats in the food.

Sweetness is a taste which is relished by human beings as well as many organisms and has a universal and uncontested appeal. This taste creates the gustatory response which is induced by many sugar molecules and their synthetic substitutes. However, sweetness come in all molecular shapes and sizes, and they could belong to diverse classes of molecules such as carbohydrates (glucose, fructose, maltose and sucrose), complex glycosides (stevioside, rebaudioside A, rebaudioside C and dulcoside), aliphatic organic compounds (cyclamate, 1,2-propanediol, oxime of perillaldehyde) and aromatic organic compounds (2-alkoxy-5-nitroaniline, phylloducin), amino acids (D-tryptophan, D-phenylalanine and D-serine), peptides (L-aspartyl-Lphenylalanine methyl ester / aspartame, hypersweet super-aspartame analogue  $p\text{-CN-C}_6\text{H}_4\text{-NHCO-L-Asp-L-(}\alpha\text{Me)PheOMe}$ ), proteins (monellin, brazzein and thaumatin) and even inorganic salts (lead nitrate, lead acetate).

It has been found prenatal infants can detect the sweet taste and human infants are born with a first choice for sweet taste. It is difficult to say when the primitive humans tasted sweet ripe fruits and became fond of it, but in ancient Greek, philosopher Theophrastus (372-287 BC) wrote a review on the sweet taste of some plant materials. Afterwards, several attempts have been made to draw a correlation between the chemical structure and sweet taste. Till the fourteenth century, people used honey as the main source of sweet when commercial supplies of sucrose from the stem of sugar cane arrived in the European markets to satisfy mankind's appetite for sweetness. In the last century, undesirable health effects of sucrose made researchers seek for sucrose substitutes and people switched for artificial sweeteners, like saccharin, dulcin, cyclamate, aspartame, sucralose and alitame. It is difficult to find a very specific scale (like the Scoville scale, which is applied to measure the spiciness of peppers by measuring the amount of capsaicin present in it) for measuring sweetness as we have found that a variety of compounds could be sweet on our tongue.

However, the standard approach is to take sucrose as base compound with 3% sucrose solution measuring the sweetness value 1, and then to compare all other sweeteners with respect to this sweetness value. The table below shows where different compounds stand in the sweetness values with respect to sucrose.

The sweetness table:

Serial No.	Compounds	Class of compound	Sweetness
1.	Sucrose	Carbohydrate	1
2.	Lactose	Carbohydrate	0.16
3.	Fructose	Carbohydrate	1.50-1.70
4.	Maltose	Carbohydrate	0.33
5.	Glucose	Carbohydrate	0.7-0.8
6.	Sucralose	Carbohydrate	600
7.	Saccharin	Aromatic sulfonyl	300-500
8.	Dulcin	Aromatic derivative of urea	70-350
9.	Cyclamate	Aliphatic sulfamic acid	30-60
10.	Stevioside	Glycoside	40-300
11.	Aspartame	Peptide	160-200
12.	Alitame	Peptide	2900

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## COVID-19 RELATED ARTICLES

### **mRNA Vaccines - the awaited COVID-19 vaccine ?**

By Seerat Sekhon, B.Sc(H) Chemistry-II Year

The year 2020 is quintessential to the times when the whole of mankind is either waiting for a perfect drug to treat COVID-19, or wants to get vaccinated against coronavirus. As of now, most of the drug candidates are empowering us to save a lot of lives but aren't enough to get back to normal, which leaves us with the latter option of vaccines. Vaccination has been central in eradicating multiple infectious diseases, like smallpox, measles & polio. It is the process in which antigens (pathogens inactivated by heat or chemical reaction) are introduced artificially into the body to stimulate the immune system. This stimulation results in production of T cells, antibody-making B cells and the long-lived memory cells. Antibodies are directed against pathogens & prevents it from infecting the cells, while certain T cells are especially effective at killing infected cells. Therefore, the Vaccination process enables our immune system to produce a more rapid and efficient response to a real infection caused by an active pathogen.

However, producing vaccines is a long and complex process, and it has been difficult to implement vaccines against certain evolving pathogens like Ebola, Marburg & Zika. Thus, to address the challenges posed to designing new vaccines, many improvements are introduced via computation prediction techniques. Development of nucleotide vaccines based on DNA & RNA is one such promising area of progress in improving vaccine design. The way these nucleotide vaccines work is a bit different from conventional protein-based vaccines. The considerable progress in DNA sequencing has made determination of genome sequence of the pathogen, & consequently, the in vitro production of DNA/RNA relatively easier. The injected DNA/ RNA of the required pathogen protein encodes the information to produce the antigen (a protein from a pathogen). Antigen when exposed to the cell surface stimulates the immune system of the body. 'Having protein made inside the cell seems to give better antigen presentation,' says immunologist Drew Weissman from the University of Pennsylvania, US. These vaccines can be delivered using a number of methods: via needle-syringe injections or needle-free into the skin; via injection into the blood, muscle, lymph node or directly into organs; or via a nasal spray. Although, the optimal route for vaccine delivery is not yet known.

The advantages of these vaccines over conventional protein based vaccines is that their production employs a much simpler process than the culture of virus in eggs, which can also provoke allergic reactions while the in-vitro production of DNA/ RNA avoids this possibility. Moreover, the nucleotide vaccines are produced at much faster rates, with less capital involved than producing the full antigen protein. This rapid production could be a major advantage in face of sudden pandemics. Moreover, it's not only the economics that pushes us in this direction but also the flexibility of these vaccines in treating rapidly evolving pathogens. For instance, influenza vaccines need to be tailored each year to specific strains that are most likely to cause disease the coming season.

Though the functioning of both DNA and RNA vaccines is similar in many ways, still the RNA vaccines have some distinct advantages. They use synthetic messenger RNA strands that encode proteins from the virus surface, usually encapsulated in lipid nanoparticles, to provoke an immune response to the virus, which appeared to perform better than DNA-based vaccines. Another is that the injection of RNA presents no risk of disrupting the cell's natural DNA sequence, whereas DNA based vaccines do pose a threat. Therefore, RNA-based vaccines offer a comparatively simple and rapid solution to unpredictable, rapidly evolving pathogens.

But current mRNA vaccines are fragile and can lose their efficiency when exposed at freezing or high temperatures due to rapid degradation of RNA in that form, and must be stored at 2-8°C. Thus, preserving the cold chain is a major hurdle for the implementation of the vaccine campaign. Fortunately, scientists have found ways to combat this RNA degradation by changing RNA's sequence to ease their storage or by binding molecules to RNA for its protection. Such engineering enables the storage of RNA vaccines at room temperature for at least 18 months, making RNA vaccines particularly practical for developing countries. As most RNA vaccine development has been directed towards highly profitable personalised treatments for cancer and rare diseases, so, their production is mostly geared towards small numbers of doses. There is no licensed RNA that is being manufactured in tens or hundreds of millions of doses. But, the Covid-19 outbreak could provide the stimulus to develop these facilities.

One of the mRNA vaccines' developers at imperial, Shattock, downloaded the genome sequence of the coronavirus when it was released by Chinese scientists. He used it to sequence RNA for spike proteins & made a template for mRNA vaccine in two weeks, whereas the normal cycle for developing a vaccine takes at least two years. While he encoded all of the spike protein, there were scientists who were encoding parts of it in developing the mRNA vaccine. The best employable strategy for mRNA vaccine development can be known only when data from animal models is obtained. Hence, to test whether his RNA sequences generated enough antibodies to block viral entry, he deployed a pseudo-virus, with an HIV backbone, incorporating the spike protein. He started his trials in mice and the results made him speculate that two or three RNA vaccines will ultimately be selected for larger trials against Sars-CoV-2. In late February, biotech Moderna sent mRNA vaccines for Sars-CoV-2 to the US National Institutes of Health (NIH) for a first-in-man clinical trial. CureVac, a German-based company specialising in mRNA vaccines, also plans to start clinical trials against Sars-CoV-2 in early summer, and a third company, BioNTech in Germany, says it has begun preclinical research on a vaccine. Considering the societal impact of Covid-19, regulators have to consider a fast-track process to get mRNA vaccines to people sooner. Otherwise, a vaccine may not be approved for two years, and mRNA vaccines could once again end up sidelined, waiting for the next big outbreak.

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## COVID19 TESTING: rtPCR and CRISPRCas9 explained

By Disha Kashyap, B.Sc(H) Chemistry, II Year

The Covid19 pandemic has become a disturbing nightmare for us all. The corona virus has spread across the world with the number of cases doubling in just days. Diagnosis is the first step in tracking and monitoring the spread of the disease. This article takes a look at the current testing techniques, and a major breakthrough in India by the CSIR IGIB Institute- a paper strip named “Feluda” that can detect Covid19 within minutes- a branch off of “SHERLOCK” developed by MIT-Harvard and “DETECTR” from UC Berkeley.

SARS-CoV-2 consists of a protein coat and simple RNA as genetic material but it has the ability to thwart a complex host like the human being. Current testing techniques make use of this very genetic material for its detection.

Specimens of the virus are collected in the form of swabs from the nose and throat- places where the virus is found to reside. This procedure is common for screening for other respiratory disorders as well. After the swabs have been collected, the RNA genetic material of the virus is extracted and purified. Making use of a very important tool of molecular biology, the reverse transcriptase polymerase chain reaction or rtPCR, the RNA of the virus is converted to its complementary DNA. After the viral DNA is obtained, its number of copies are multiplied by several thousands or amplified. During this process of amplification, certain fluorescent dyes are also introduced in the medium and bind to the viral DNA as it is being copied.

If the sample contains viral DNA, as more and more copies are made, the dyes bind and the fluorescent signal crosses a threshold- the test comes positive. If viral DNA is not present in the sample, the fluorescence of the sample doesn't reach the threshold value and no fluorescence is seen- the test comes negative. Problems associated with this type testing are mainly its time-consuming nature, expensive reagents and false-positives due to the contamination of reagents.

Future tests are looking to expand into the realm of CRISPR (clustered regularly interspaced short palindromic repeats)-CRISPR associated protein (Cas) technology. The CRISPR-Cas system is found in nature as an immunity defense mechanism in bacteria that targets the genetic material of viral invaders. This tool provides us with the ability to manipulate genetic information for purposes ranging from the study of genetic function to the revealing of mechanisms of biology. The system comprises a CRISPR RNA or crRNA which guides the associated protein for ensuring exquisite selectivity. During an invasion, upon exposure to foreign genetic material, short fragments of the invader's DNA are incorporated into the crRNA through a process known as hybridization. The associated protein then cleaves the target nucleic acid neutralizing the threat. The RNA will only be cleaved by the protein if it contains that specific sequence.

“SHERLOCK” makes use of pre-amplified Covid19 viral RNA designed synthetically incorporated in the crRNA- since this RNA is of experimental design, guide RNA or gRNA is a more appropriate term- and Cas13 protein system for detection.

[https://www.broadinstitute.org/files/publications/special/COVID-19-detection-\(updated\).pdf](https://www.broadinstitute.org/files/publications/special/COVID-19-detection-(updated).pdf)

“DETECTR” involves designed gRNA containing sequences from SARS-CoV-2 or multiple coronavirus strains and the Cas12 protein.

<https://mammoth.bio/wp-content/uploads/2020/02/A-protocol-for-rapid-detection-of-the-2019-novel-coronavirus-SARS-CoV-2-using-CRISPR-diagnostics-SARS-CoV-2-DETECTR.pdf>  
 “Feluda” makes use of the Cas9 protein.  
<https://timesofindia.indiatimes.com/life-style/books/features/new-coronavirus-test-is-named-feluda/articleshow/75222554.cms>

The advantages of CRISPR-mediated detection include high specificity and fast results-obtained within a matter of minutes as opposed to the hours devoted for the rtPCR-based test. The battle against Covid19 is raging on. Several lives have been lost but we continue to fight steadily with a more cautioned spirit and sharpened minds. If nothing else, the pandemic has reminded us of the true value of human life and the extent we must go to protect it.

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## Science Diplomacy in times of COVID-19 Pandemic

**(PS : Ignoring science until a crisis is a prescription for disaster)**

By Seerat Sekhon , B.Sc(H) Chemistry-II year

The success of the Science-policy interface entirely depends on whether the politicians have done the right thing at the right time in line with the available scientific advice. The importance of Science diplomacy has been highlighted surrealistically in the face of an infectious disease that knows no borders, which has unilaterally regulated the extent of COVID-19 challenges. Joseph Wu and his colleagues, based on their modelling of the Wuhan outbreak of COVID-19, wrote in *The Lancet* on Jan 31, 2020 : “On the present trajectory, 2019-nCoV could be about to become a global epidemic. For health protection within China and internationally, preparedness plans should be readied for deployment at short notice, including securing supply chains of pharmaceuticals, personal protective equipment, hospital supplies, and the necessary human resources to deal with the consequences of a global outbreak of this magnitude.”

Though Chinese government failed to alert the world & supply diagnostic data and infection statistics at the early stages of the virus outbreak, but this warning wasn't made lightly. It should have been considered by the Chief Medical Officer, the Chief Scientific Adviser and the Chief Executive Officer of the NHS in the USA, England & other European countries with utmost gravity. February should have been used to expand coronavirus testing capacity, ensure the distribution of WHO-approved PPE, and establish training programmes and guidelines to protect NHS staff. But, they didn't take any of those actions. The reluctance of Governments to acknowledge the wary of the scientific fraternity has led to this "international scandal" whose gravity is yet to be understood. Had the governments acted early and in unison, the public health and economic impacts would have been far less.

It's not only the Government's Contain-Delay-Mitigate-Research strategy but also the misinformation campaign by some of the government leaders and actors on social media which has created public confusion and is responsible for delayed action. For instance, popping of Famotidine, a heartburn medicine, as a remedy against the coronavirus highlighted the dichotomy between science & real world. Trial studies for evaluating Famotidine's efficacy were proposed, but the increasing popularity of Trump's "game changer" anti-malarial drug among hospitalised COVID-19 patients made it difficult for the investigators to carry out these tests. The patients were ready to volunteer only if the trial tested for a combination of famotidine and hydroxychloroquine i.e. half of the patient in the study will be given famotidine in addition to hydroxychloroquine & the other half will be given intravenous saline as a placebo, which has no effect. One of the analysts involved in testing said "You have to be fair to people - they're reading in the paper and hearing on the news that hydroxychloroquine works and they look at their dying wife or grandma or child and they want to try it and how could we say no? What kind of person would say no?"

Hence, the touting of anti-malarial drug as the only remedy for coronavirus has not only made evaluation of famotidine's efficacy difficult, but will also pose a challenge to any advancement at times when hydroxychloroquine has become the standard of care for COVID-19 patients. The failure of countries with highly capable science advisory ecosystems to act wisely & early when the worldwide public health community is well aware of the pandemic threats, thanks to 2003 SARS, MERS Ebola & Avian Flu, illustrates what can be lost if the science advisory systems at the national and global levels are flawed and political leaders do not listen to highly expert scientific advice.

The right policies employed in putting science on the diplomatic table not only include implementing the apt strategy at right times but also increasing worldwide collaboration of scientists. The creation of the Intergovernmental Panel on Climate Change (IPCC) is quintessential to realise how the partnership of the worldwide scientific community, national governments, and the U.N. has helped us better realise the implications of anthropogenic climate change and formulate policies that could help mitigate the damages. This led to formulation of the 2015 Paris Climate Agreement where 17 Sustainable Development Goals (SDGs) were negotiated and included in the UN 2030 agenda. This showed that if accepted norms of transparency & ethics in scientific collaboration are followed and ensured, the collaboration of governments & scientific institutions results in formulation of right policies.



The publishing of genome sequencing of the virus in a leading medical journal, *The Lancet*, by Chinese medical & scientific community, provides us a hope that the current political tensions and the pandemic will not cause further roadblocks to building better science advisory ecosystems. And as I write this, I hope that the present acceleration in global scientific enterprise to defeat SARS-COV-2 will not only empower us to deal with global challenges like these but also advance science by strengthening international scientific partnerships and collective action.

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## SOCIETY EVENTS 2019-20

### The Inaugural Lecture

### NanoTechnology for Societal Benefit by Prof Neeraj Khare, IITD



The Inaugural lecture of The Chemistry Society, St. Stephen's college on "Nanotechnology for societal benefit" was delivered by an eminent physicist from IIT Delhi, Nano Research Faculty Prof. Neeraj Khare. The talk was highly informative on the subject of nanoscale research and its potential benefits to mankind in the coming future. The premier thing we learned from the talk was that nanoscience is no more confined to laboratories but it is already in its first generation, this includes passive nanomaterials like Titanium Dioxide which is used in sunscreen lotions and cosmetics, Carbon allotropes used to produce gecko tapes and Silver nanoparticles which are used for food packaging, clothing, disinfectant and household appliances.

From the talk we came to a realization that nanosciences are almost mimicry of the "technology of nature" and nature is full of solutions to many of the challenges we encounter. The vivid blue color of the blue morpho butterfly is actually due to the presence of many sandwiched layers of nanoscale structures on its wings. The numerous reflections from these equally spaced layers create constructive interference patterns resulting in very intense blue colors.

Another good example of “nanotechnology of nature” from the talk was magnetotactic bacteria which synthesize magnetic iron nanominerals which function as tiny compasses that allow the microbes to navigate using the Earth’s geomagnetic field. There are various examples of nanotechnology to some extent being practiced in earlier times. In the 9th – 17th centuries, glittering “luster” ceramic glazes used in Islamic world and later in Europe contained silver and copper nanoparticles. Also, Lycurgus cups contained silver nanoparticles and ‘Damascus’ saber blades contained carbon nanotubes and cementite nanowires.

This talk also helped us to finally grasp the concept and prospects of quantum dots in nanotechnology. A quantum dot is a nanoparticle made of any semiconductor material such as Silicon, Cadmium Selenide and Calcium Sulfide nanoparticles. Silicon dots and Lead Sulfide quantum dots can generate two electrons for a single photon of light thereby increasing the efficiency of solar cells. Researchers are also working on use of quantum dots in displays for applications ranging from cell phones to large screen televisions that would consume less power than current displays.

Lastly, Prof. Neeraj Khare talked about the application of nanotechnology in cancer research. Nanotechnology offers the means to target chemotherapies directly and selectively to cancerous cells and neoplasms, guide in surgical resection of tumors, and enhance the therapeutic efficacy of radiation-based and other modalities. Nanosciences is gaining popularity as a research field in recent years. The lecture on nanotechnology motivated research aspirants like us, to explore the developing field of nanoscience, which have high scope in future research prospects. In order to keep up with the ever developing world of science, it is important that more young research aspirants get into newer fields of applied sciences. Talks like these are quintessential to introduce the future researchers with fields of applied sciences like nanosciences.

## **Borosil Workshop**

Science is incomplete without conducting experiments in laboratories and so are the shelves of Chemistry labs without Borosil glassware like burettes, pipettes, test tubes, conical flasks and many more. The Chemistry Society of St. Stephen's College, organised 'The Borosil Workshop' on September 5, 2019. Mr. Himanshu Sharma, the senior sales executive at Borosil Ltd, threw some light on different properties of borosil glass (chemical resistance, thermal shock resistance and crystal clarity to name a few) which make it desirable in laboratories and households alike.

The workshop focussed on some major topics- process involved in cleaning of glass apparatus as clean apparatuses are prerequisites to correct results, steps involved in manufacturing borosil apparatus and most importantly the 'do's and don'ts' which must be strictly followed while working in the laboratory. Overall the workshop was extremely helpful for the students who have just stepped into this massive world of chemicals. Thanks to the Borosil Workshop, there won't be another student blowing into the pipette or casually tilting the test tube towards a classmate while it is being heated.



## IYPT Lecture by Dr. Anupama Dutta



“Be not afraid of growing slowly; be afraid only of standing still.” The Chemistry Society of St. Stephen's College, celebrating the International Year of Periodic Table, heartily acknowledged the efforts and the never stopping spirit of our revered scientists by virtue of who we are, what we are today. On this occasion, an inaugural talk on “Role of Chemical Elements in Disease Management” was organized on October 22, 2019, by a well reputed scientist at DRDO- Dr. Anupama Dutta. Dr. Dutta is a scientist at the Institute of Nuclear Medicines and Allied Sciences, DRDO. Her field of research includes Design and Development of Novel Probes for Targeted Imaging and Therapy. She has been a postdoctoral researcher at the Technical University Darmstadt, Germany.

The talk was indeed very pivotal as it shed light on the importance and impact of the periodic table on our daily lives specifically with respect to nuclear medicine, with a special mention on its future aspects. This was followed by an exhilarating Science quiz- the Chem-a-thon in which various cross-college teams participated. The mind-boggling audio and visual questions appraised our knowledge across several disciplines in Science and exponentially improved our learning curve! In a nutshell, celebrating the International Year of Periodic Table, with such zest and fervor enhanced our understanding and appreciation of the Periodic Table. It was an enriching experience which opened doors of our knowledge to how indispensable the Periodic Table of elements is to science and is a uniting scientific concept, with broad implications in Astronomy, chemistry, Physics, Biology and other natural sciences.

## **CHEMATHON - THE SCIENCE QUIZ**

Knowledge is of no value unless it is put into practise. Keeping this in mind, The Chemistry Society of St. Stephen's College organised its well-known science quiz- Chemathon . Through its years of existence, the society has come to be well known for organizing events that witness enthusiastic participation of teams from colleges all across Delhi.

22<sup>nd</sup> October heralded the quiz , the format of which entailed multiple rounds including a screening round. Participating teams consisted of two members each. With every round, few teams were eliminated. The time allotted to give the correct answer was ten seconds, failing which the question was passed to the next team. In case, none of the teams were able to answer correctly, the question was open for the audience. There was a fierce competition between the teams, to an extent that in the race to finals, the quiz experienced a tie twice. Finally, only two teams out of about twenty, made it to the finals. The winners of the quiz were awarded a certificate of merit. There was much excitement in every participating team and the event ended on a jubilant note!

## INTERNSHIP EXPERIENCES

### A Summer at IIT Goa

By Pempa Tshering Bhutia , B.Sc(H) Chemistry- III year

Goa, yes Goa! Beaches, churches, Portuguese architecture, it was a dream come true. My 6 week internship was based in Indian Institute of Technology, Goa. I gained an opportunity to work in the field of Organic Synthesis under the supervision of Dr. Rishikesh Narayan.

It was a one hour long drive from the airport to the campus. As I crossed the beautiful coconut trees, tiny houses and many lakes, I was excited and scared about my internship. After reaching the campus, I met my professor who happened to be an alumni of our neighbor, Hindu college. He welcomed me wholeheartedly and showed me the entire laboratory. I was blue and white, I fell in love with it. My experimental work focused on synthesis of organic compounds. I learnt setting up reactions, monitoring the progress of the reaction via Thin Column Chromatography and also through stains. I learnt that after the reaction goes to completion, you are done with just 50% of the work. I was introduced to the concept of work-up then. After work-up, to evaporate out the solvent used, I used rotavapor for the same. Then using column chromatography, the compound was purified. The obtained compound then is taken for NMR then. I would like to state now that it is so easy how we write an *n-step* organic reaction so easily in paper but how difficult it is to actually perform it in the lab. Some reactions take days and days, while column chromatography may take a whole day. But, I believe the satisfaction you obtain on getting the final product compensates it all.

Apart from the experiments that I performed, I made some great friends. Being the youngest there, I was loved and pampered by all. Every Sunday was an off day for me which was utilised in visiting forts and beaches around. This internship made me a more confident person working in a laboratory. The memories made there are priceless and I would cherish them forever!

PS: Recently, I had a video call with my friends from IIT Goa. It seemed nothing had changed after all! I got friends for life through this internship.

**MY SUMMER OF 2019 @ IIT-B*****from epoxides to marine drive***

By Siddhant Dhingra , B.Sc(H) Chemistry-II year

Super-excited by the word “internship”, the freshman self of mine had applied for the National Initiative for Undergraduate Sciences (NIUS) by the HBCSE, Mumbai. I had become completely oblivious of the application and its results when suddenly I received the “congratulations” over a call for the selection from a friend. The camp in December was a once in a lifetime experience with informative lectures, mind boggling lab sessions and a scary interview at the end of it for project allotment and selection.

My happiness knew no bounds when I was selected for “enantioselective epoxidation” under Prof Santosh J Gharpure at IIT-Bombay. With anxiety soaring high and a bittersweet numbness, I boarded the flight for a journey to my summer research internship 2019, a time which I didn't know I'll call one of the best summers of my life.

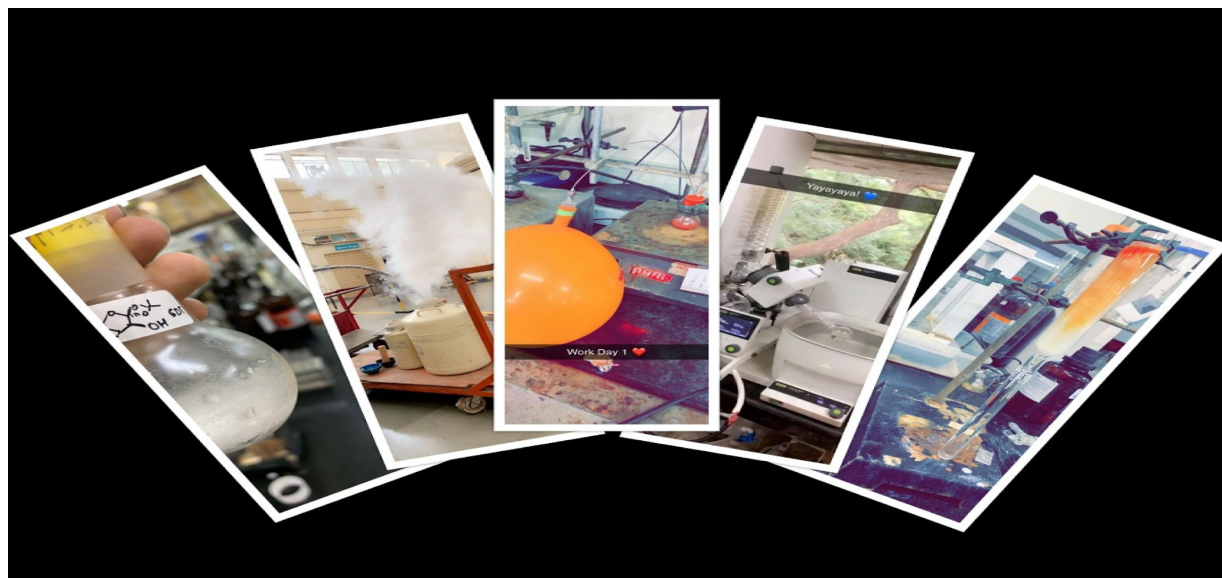
Boarding a mumbai local bus from anushakti nagar to IIT Market right at 9 in the morning, laborious organic synthesis (trust me there are days when you really feel that you'd rather build a wall using bricks and cement than structuring a molecule synthetically), having lunch in 10 minutes and leaving the premises to reach the lodging via the same route at 7 PM each day was what the coming 6 weeks were about. The whiff of an organic lab is something that I don't need to mention!

The experience was indeed learning and fun enriched. 900 miles away from college, It is close to impossible to see your senior Tina shouting “Siddhant” in the IIT-B corridors! What are the odds, haha! Along with this, each saturday evening and sunday meant a good outing with my friends at hbcse who were also interning with different professors across mumbai. Evenings at marine drive, driving through bandra worli sea link and eating at chowpati are the perks of mumbai that I'll never fail to cherish!

The exposure to Self Made TLC plates, dancing RotaVapor, never ending column chromatography, use of liquid nitrogen, preparing dry solvents and filling up nitrogen balloons was an amazing experience coupled with “chai breaks” and my favourite peanut butter chikki available at IIT canteen. I was put under a PhD senior to mentor me throughout the literature survey, setting up the reaction, monitoring it and its final work up. The scariest part of the project was the NMR (apart from handing pyridine-for obvious reasons, haha!). Ever waited for your blood reports when tested for a disease, well then you know exactly how I felt waiting for my NMR results so we could interpret them. Any wrong peak in that sheet would render the entire synthesis in vain. I essentially worked on the synthesis of the “shi catalyst” required for effective epoxidation of dibromide substrates. The reaction required administering -5 degree Celsius temperature for 6.5 hours straight. And it would not be a surprise to any chemist that I did not succeed in my first attempt. (Well neither in the 6th attempt, haha!) After a month (nearing the end of my term there) finally I obtained my sought for catalyst in a 60%-ish yield, fortunately! I learnt that experimentation and research is not only about successes but each failed attempt tells us what will not be repeated in future. But yes, my rants about those failed reactions were something that only my family and friends had to deal with (Naturals' Ice Cream came to the rescue then). From gaining insights about good literature surveys to interpreting my NMR and Mass Spectra, I can say I learnt a lot as a chemist!

Someone who couldn't wake up for school on his own was now travelling alone in Mumbai buses. Someone scared of heavy winds was now living in Mumbai at the time of cyclone "Vaayu". Someone who was scared of a mosquito repellent spray was breathing live in an organic lab. Someone who was always completely disciplined was now travelling in Mumbai locals without a ticket. Someone who went to Mumbai for JUST an "internship" came back grown, matured and as a proud "research scholar" !

Thanks to the complexity of Organic Chemistry and Mumbai for everything!



### MY INTERNSHIP EXPERIENCE AT INDIAN INSTITUTE OF SCIENTIFIC EDUCATION AND RESEARCH (IISER-B)

by Cheshta Chopra, B.Sc. (H) Chemistry , 3<sup>rd</sup> year

Internships are basically meant to provide us with some experience of working at a research lab or doing any other kinds of work under someone's guidance. It is always a pleasure to be guided by someone who is an expert in the field. There's always a lot to learn from everyone and anyone. And I believe that the process of learning should never stop.

In my first year , I had a very nice long two months break and I spent them enjoying it. At that time we weren't aware of something called an internship. And we merely thought of it that only 2<sup>nd</sup> and 3<sup>rd</sup> years do. But deep down , those vacations were full of boredom and laziness which made me conclude that I ought to enquire more about what it is like to work in a research lab . And from that very moment I started troubling my seniors asking for help . (we all do that) .

I applied for SRPF by the Indian Academy of Sciences and one more internship by TIFR. The results came around January and February . I was very disheartened because I couldn't get an internship in any of them . I also remembered my seniors telling me to mail the professors , but I didn't know whom to mail. I sent emails to a few professors on my own but in vain. Then one of my professors told me to mail a professor of IISER-B and through her guidance and help , I managed to get an internship there.



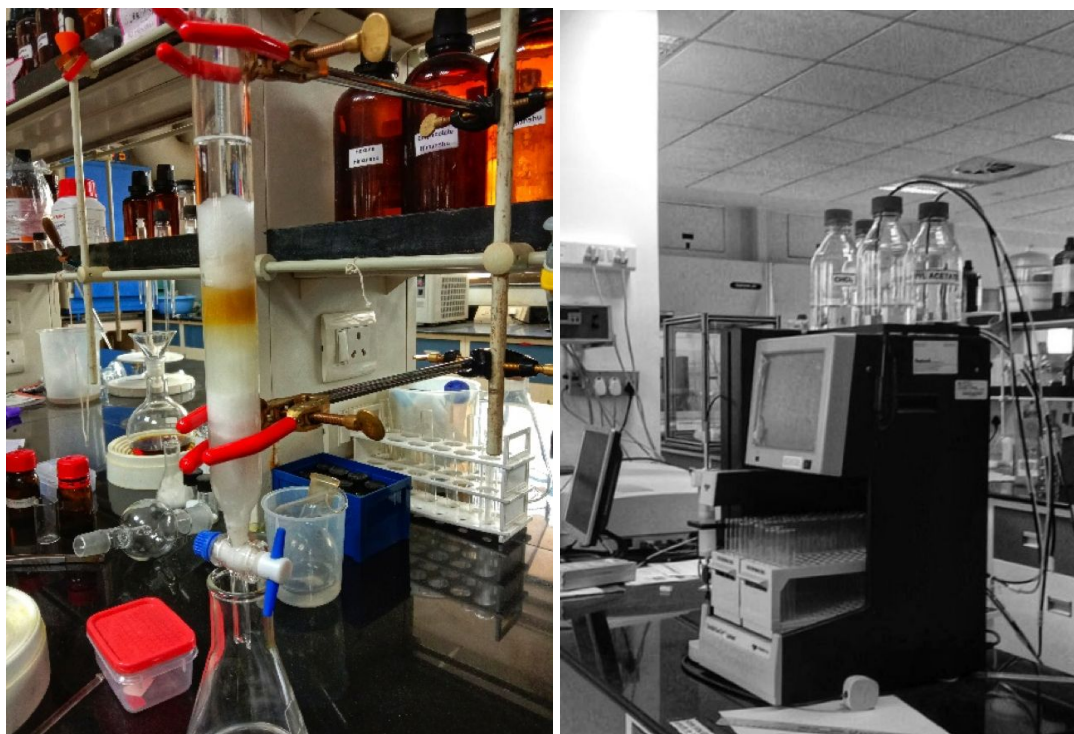
The period of my stay there was from 1<sup>st</sup> June '19 to 15<sup>th</sup> July '19. I worked in the lab of Dr.Aasheesh Srivastava, HOD , Chemistry Department , IISER-B. I worked in the field of Supramolecular Chemistry (Self Assembly of a Helical Molecule). Basically since it was an organic synthesis lab , my work consisted of setting up reactions , monitoring the progress through Thin Layer Chromatography , separating the products using column chromatography, taking NMR spectra , mass spectra , etc. All this work seems to be difficult for a second year student and of course I was very well guided by sir and all the PhD scholars.

The reactions were as simple as coupling reactions, nitration, and etc. But these seem to be easier only theoretically. While doing them in practice is really a tedious job. Column chromatography taught me a lot of patience, it went on for hours. Sometimes I felt like running away but I continued doing it. Being inquisitive and observant, I also observed what others in the lab did. The lab members also had a weekly ritual of lab cleaning, which was fun to be a part of. I slowly became a part of the group and everyone had something to teach me which I may cherish forever. I am really thankful to sir for having me as a summer intern in his lab. Apart from being in the lab , I also spent my time in the library reading books and studying. It was one of the best libraries I had been to till date.

Talking about my stay there, it was my first time away from home, so the initial days were miserable for me. I felt extremely homesick. I was fortunately accompanied by my classmate Neha. I slowly became used to living there and started making friends with a lot of people. The weather went from very harsh summers to extremely beautiful downpours. The sunsets were an extreme delight to the eyes. Each Sunday I went to explore the city of Bhopal and those weekend getaways were very relieving.

The campus in itself was very beautiful and late night walks became part of daily chores for me. From working late in the lab to watching cricket matches together. From cribbing over the taste of food to getting drenched in the rain. From sharing umbrellas to sharing the last bites of gulab jamuns. It was an enriching experience which taught me a lot of things apart from the scientific work that I undertook.





### Research Experience at St. Stephen's College

By Diksha Dewan, Mukund Sharma, and Sakshi Sharma, BSc. Hons. Chemistry-I Year

*“Work in the laboratory as a science student, not as a labourer.”* These priceless words by our professors have taught us to reason out why and why not and think out of the box. Being first year students, while sucking liquids through the stalagmometer for determining their surface tension, we were intrigued by a very basic question “Why to use this complex stalagmometer, whose name itself is so different to pronounce? Can't we use a burette for the same?” This query embarked us on a beautiful odyssey of our very first research project of our lives. Our mentor for the same was Dr. Priyanka Thakral and the project is entitled as *‘Analysis of accuracy of burette in determination of surface tension of liquids and its variation with rate of flow and inclination angle.’*

We feel that the three months i.e. January to March, during which we worked on this research project, was the best time of college for us. Reliving those days automatically brings a gleam of smile on our faces. Even, right now, penning down our experiences, we are chuckling on our stupidity and cherishing the priceless knowledge deep in our hearts. There were times of despair as well, when we were lost in uncertainties; when burdened with endless tests and assignments, seeing our fellow classmates living an easy going life while we were counting the number of drops falling from the burette!! Indeed that was irritating but now we know, “No pain, no gain.”

This research experience, being the first original research work carried out by us, has taught us a lot—from getting to know how to read a research paper, what a copyright is, to how pivotal troubleshooting is! We can never turn the blunder of putting in value of diameter instead of radius, to the back seat of our lives, as this small mistake ended us in baffling, vague results. We, now, know how important patience, optimism and a tension-free mind are in discovering the reality behind appearances. We still remember, dancing on the Doraemon title track, in the laboratory when we got beautiful results! Really, this experience has strengthened our trio friendship, our bond with the ever helping seniors and supporting lab staff.

Wholeheartedly, we owe a great regard to our mentor, Dr. Priyanka Thakral, who has always been with us through thick and thin. Her endless support and encouragement at every point of time has been the impetus for our work; by virtue of which, we even bagged second position at Inter-college Oral Paper Presentation held at Gargi College, University of Delhi, for the same research project. In a nutshell, we three, deem this research experience as a golden opportunity and a stepping stone for all further research projects.

### **My experience of HBCSE-NIUS Winter Camp 2019**

By Mukund Sharma and Sakshi Sharma, BSc. Hons. Chemistry-I Year

During my first month at Stephen's, I still remember, most of my batch-mates were exploring the college and making new friends and gathering information from the seniors about what is to happen in the months to follow. There I came across this alien term 'NIUS-internship'. Honestly speaking, I was literally all the time thinking about how to get an internship. Soon the applications for this were out and I, like nearly batch-mates of mine, applied for this. The competition here at Stephen's is such that you belittle your own self. So was the case with me and I had given up hopes on getting selected for this. But on 20<sup>th</sup> of November, the results were out and I had been selected for this!

When I arrived, for the first time in my life, in Mumbai, I was awestruck by the High rise building and the busy life of people here. I got to admit the fact that the financial capital of the country is 20 years ahead of Delhi! I was a bit afraid too, for I was wondering what if they give me a project, something which I am not able to simply understand. But this proved to be a very absurd thought when I met the people here. Here comes the best part of my experience. I met so many like-minded people from all over the country and we all interacted very well. We helped each other and discussed a lot about science. They were all simple minded and nice people. In fact a friend of mine was a silver medallist at the International chemical Olympiad. We also had discussions about everything that is good in our native cities. Here comes yet another important part of my NIUS camp. It is called the mafia! Mafia is a pretty famous game that anyone who visits HBCSE falls in love with. Enjoyment that I found in playing that game with friends of mine can simply not be described. This game has cemented our bonds.

On our very first day, we were put into groups for the lab activity. My group focussed on a project related to Indigo dye. The lab sessions were not like the ones we have in schools or colleges. It was very different. We were made independent from the beginning and none of our mentors gave us direct answers. We had to think, discuss with other group members and had to come to conclusions. Experiments can't be done solely. Scientific research doesn't work that way. We had to accept our ignorance and mistakes. We argued a lot and came up with possible explanations for the results that we got. We even came up with certain open ended possible research questions.

After gathering all the results together, we had to make a poster and present it in front of professors. We had a Q&A session and were drilled with questions ruthlessly. It was an amazing experience to try and defend our work in front of so many people. We had to read actual scientific research papers and also had to write abstracts based on our understanding of the paper. This made us realise the importance of reading papers. If we want to do research work, we need to keep ourselves updated with the scientific literature.

After these presentations were done with, we were given a tentative list of available projects and had to choose a field of interest. The next day we had to attend an interview with professors related to that field. Eventually I was given a project in the field of Computational chemistry and will again be going back to work at BARC Lab.

### **Research Experience @IIT DELHI, Centre for Biomedical Engineering**

By Disha Kashyap, B.Sc. (H) Chemistry- II year

“All the world is a laboratory to the inquiring mind” Reading, understanding and memorising concepts only gets one so far, several challenges lie at the juncture between the theoretical and the practical, and learning how to tackle them is at the core of being a great scientist. Thus, the conversion of the theoretical to the practical is where my real interest lies. I wholeheartedly recognise that mastering experimental techniques is extremely crucial for holistic learning and the development of a scientific aptitude.

During the course of my first summer as an undergraduate student of Chemistry, I ventured into the world of biomedical engineering. Working under Dr. Neetu Singh at the Indian Institute of Technology, Delhi, I employed the biopolymer silk-fibroin as a template for synthesising silver nanoparticles (AgNPs). The resultant silk-fibroin films embedded with AgNPs were then subjected to different solvent (methanol and water) treatments at the last step of processing. The anti-microbial properties of such films are well-known but the purpose of this study was to determine how much of a role processing solvents play.

Towards this end, I carried out anti-microbial and biofilm-disrupting testing techniques such as the colony-count method, Alamar blue assay, and spectrophotometric analysis of optical density against Gram-positive *S. Aureus* and Gram-negative *P. aeruginosa*. This study has implications in the designing of various biomedical devices for purposes ranging from scaffolds to sutures, and in combating various hospital-acquired infections that spread through bacterial biofilms. I also learnt chemical routes for the synthesis of metallic nanoparticles (silver, gold) polyethylene glycol nanoparticles, pNIPAm nanogel, and carbon dots.

Furthermore, I also got familiarised with various nanoparticle characterisation techniques such as Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Dynamic Light Scattering (DLS), X-Ray Diffraction (XRD). The internship really offered me a novel outlook on how to ideate a project, conduct research, and place yourself within the larger discourse of a field as a scientist. During the mid-semester break in my current semester, as part of the certificate course on Medical Biotechnology at Miranda House, University of Delhi, I got hands-on experience in laboratory techniques involving genomic DNA and plasmid DNA isolation from *Escherichia coli* and Sap protein isolation from *Bacillus anthracis* followed by SDS-PAGE, and Western Blotting. This course also exposed me to recent advancements in the rapidly expanding field of Medical Biotechnology through several lectures.

No branch of Science has value in isolation, and only when we view the world of Science from an interdisciplinary lens can we really appreciate and understand its immense complexity. Despite pursuing a Bachelor of Science degree in “pure” Chemistry, my academic pursuits have always sought to incorporate that spirit of interconnectedness in enquiry and concept-building. And I think that’s the beauty of Science- how answers become much more apparent when we look through multiple lenses.

## **Ink From The Chemistry Lab**

### **लाचारी - राधे श्याम यादव**

मजदूर ही तो हैं,  
यह ऐसे ही मारे जायेंगे।  
अच्छा है थोड़े कम हो जायेंगे,  
जरा, चिल्लाएंगे थोड़ा हाथ पैर भी चलाएंगे।  
फिर रोटी के चक्कर में चुपचाप काम पर लग जाएंगे,  
मजदूर ही तो हैं फिर शांत हो जायेंगे।  
मजदूर ही तो हैं, ये तो ऐसे ही मारे जायेंगे,  
मजदूर ही तो हैं, जो तुमको कुर्सी पर बैठाये हैं।  
मजदूर ही तो हैं, जो तुमको कुर्सी से हटाएंगे,  
मजदूर ही तो हैं, यह ऐसे ही मारे जायेंगे ।।

### **Naina bhar bhar aaye the..**

Kaise gamm ke saaye the,  
Jo uss amber pe chhaye the..

Teri galiyan jab chodhi thi,  
Naina bhar bhar aaye the..

Pata nahi tha har din tanha  
Aur akela guzrega,  
Khud se teri baate karte,  
Door nikal hum aaye the..

Aandhi kitni tez thi uss din,  
Jaise patjhad laut ke aaye ho,  
Jis din choti baandh ke tumne,  
Peele phool lagaye the..

Yaad aata hai woh nazraane,  
Saste nahi anmol mei the wo,  
Jab hum over time laga ke,  
Tere jhumke laaye the..

**-AJAY LAZAR**



## कोरोना - राधे श्याम यादव

कोरोना कोरोना हर तरफ है,  
इसका रोना।  
बिमारी है यह बड़ी गंभीर ,  
कहर बना इसका जंजीर।  
बेड़िया बना पड़ा है पैरों में ,  
तब आया ज्ञान जीवन में।  
स्वच्छता का पाठ ऐसा पढ़ाया ,  
उम्र भर सीखे न जो ,  
सिख गये उसे भी आज ।  
धरती बनी प्रदूषण मुक्त ,  
जुर्म हुआ काफी हद तक दूर।  
कोरोना कोरोना हर तरफ है,  
इसका रोना।  
हेलो ,हाय से नमस्ते पर आ गए,  
हम अपनी संस्कृति को फिर से अपना गये ।  
दर का मंजर ऐसा छाया ,  
इंसान को सभ्यता का पाठ पढ़ाया।  
अब जागो नगरवासियों ,  
कुछ तो समझो मेरे साथियों ।  
प्रकृति से ही जीवन है,  
जीना है तो,इसे अपनाओ  
वरना मृत्यु को गले लगाओ।



## Alumni Connect

### Life in the Chemistry Department of St. Stephen's College

-Sanjna Rana( Batch of 2019)

During my first week in college I was worried that life in the Chemistry Department was going to become a monotonous never ending cycle of attending labs and lectures. I was mentally preparing myself to write assignments and lab files for the next three years while being bombarded with chemistry. But funnily enough life in college was so much more than just sitting in the library before internals and last minute assignment submissions. The professors really encouraged us to try different things in college, academics and extracurricular wise. I was taught being a Chemistry Honors student does not live up to the black and white picture of an exhausted chemist in a stained lab coat locked in the lab with a bleak look on their face. We did not just limit ourselves to academics. Leadership cells, Placement cells, theatre, sports and even the students union, we were a part of it all. In fact the presidents of the Students Union and many other societies in college were Chemistry Honors students. Another beautiful lesson we learnt was of friendship. As individuals, we were all different people from different parts of the country and differences are bound to clash. But irrespective of it all we always stood together as a united front; especially when it came to delaying submissions or any tests. That brings me to yet another lesson learnt in the art of negotiating. Setting of all assignment submission dates and internals was a negotiation between us and our professors. With an eye for detail we scrutinised every bit from the dates set to the topics given and would plead with our professors to comply with our demands so that we could take the easy way out. Yes, we were a seemingly unruly batch who made our professors suffer a lot but today we truly miss them all. I can say for a fact that I still cling on to their notes, salt analysis manuals and internal papers to relearn concepts. When we were asked to make a separate copy of fifty organic reactions we did not receive the assignment kindly at the time but now I truly am happy I did it for that has many times been a saving grace. The three years which I prepared myself for flew by in the blink of an eye with each day being better than the last. And each lesson learnt, whether academic or a life shaping one, has definitely helped me along the way and I am sure it is the same for the others as well. To conclude it all I can say is that life in the Chemistry department has been interesting and one I am glad I had the opportunity to experience.

**गुरुर्ब्रह्मा गुरुर्विष्णुः गुरुर्देवो महेश्वरः ।**

**गुरुः साक्षात् परं ब्रह्म तस्मै श्री गुरवे नमः ॥**

-Amrit (Batch of 2019)

I recall the day when I filled out the form for pursuing Chemistry at College. My dad was persuading me to apply to other courses as well but I was resilient not to apply anywhere else. Little did I know that my stubbornness will change my life forever.

My three years at St. Stephen's College was no less than a process of transformation in both my inner and outer self. The time spent shuttling between different rooms and labs in the Chemistry area of the Science Block taught me lessons in management, a feat that no MBA course can fathom to achieve. Science dhaba was always our favourite recharge and relaxation zone after long hours in the labs or classes. Mince-Anda-Maggi, electrolyte drinks and Patty were our catalysts. :P



I would consider our Senior members no less than an inspiration because of their maturity, care, affection and experience that made us feel comfortable in a place far away from home. It was their support which made our batch claim the top positions not only in academics but also in societies and college teams. It did feel a bit overwhelming at times managing every aspect of life on our own but it was the empathy and sheer motivation of our Senior members that kept pushing us to do our best and make the most of College life. I also would like to thank the Lab Staff for all their help during the practicals and teaching us the tips and tricks to get work done efficiently.

I wish to conclude my remarks with this prayer to my Senior members and my "Gurukul".

Ad Dei Gloriam!

### **"A change from a chemist to a food scientist"**

-Srishti Singh (Batch of 2019)

My life has been a roller coaster ride as I assume for everyone else. Time that I spent organising and planning events for the Chemistry Society taught me that there was more to chemistry other than just the classroom activities and there it all began.

I am writing this report in order to confirm that even though my journey started as a chemistry student at St. Stephen's College, life had different plans for me. Applied sciences are a field that interested me the most and a talk that was organised in my second, which was on the topic connection of neurological disorders and chemistry as well as on forensic reports. These two topics intrigued my interest in knowing more about applied sciences. My interest grew after I read more about biochemistry and after going deeper into the food aspects. Owing to the fact that my recent studies were regarding treatment of major depression with curcumin induced depressants.

I guess there it all began; to change a stream while pursuing masters could be tough as for me that major setback was not studying biology in bachelors and the course that I am currently pursuing required a deeper knowledge in that regard but as things started to unfold, my interest grew and so did my knowledge.

Through this report, I would remind the readers, "Dream and don't be scared". I'm sure if you can dream you can achieve.











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