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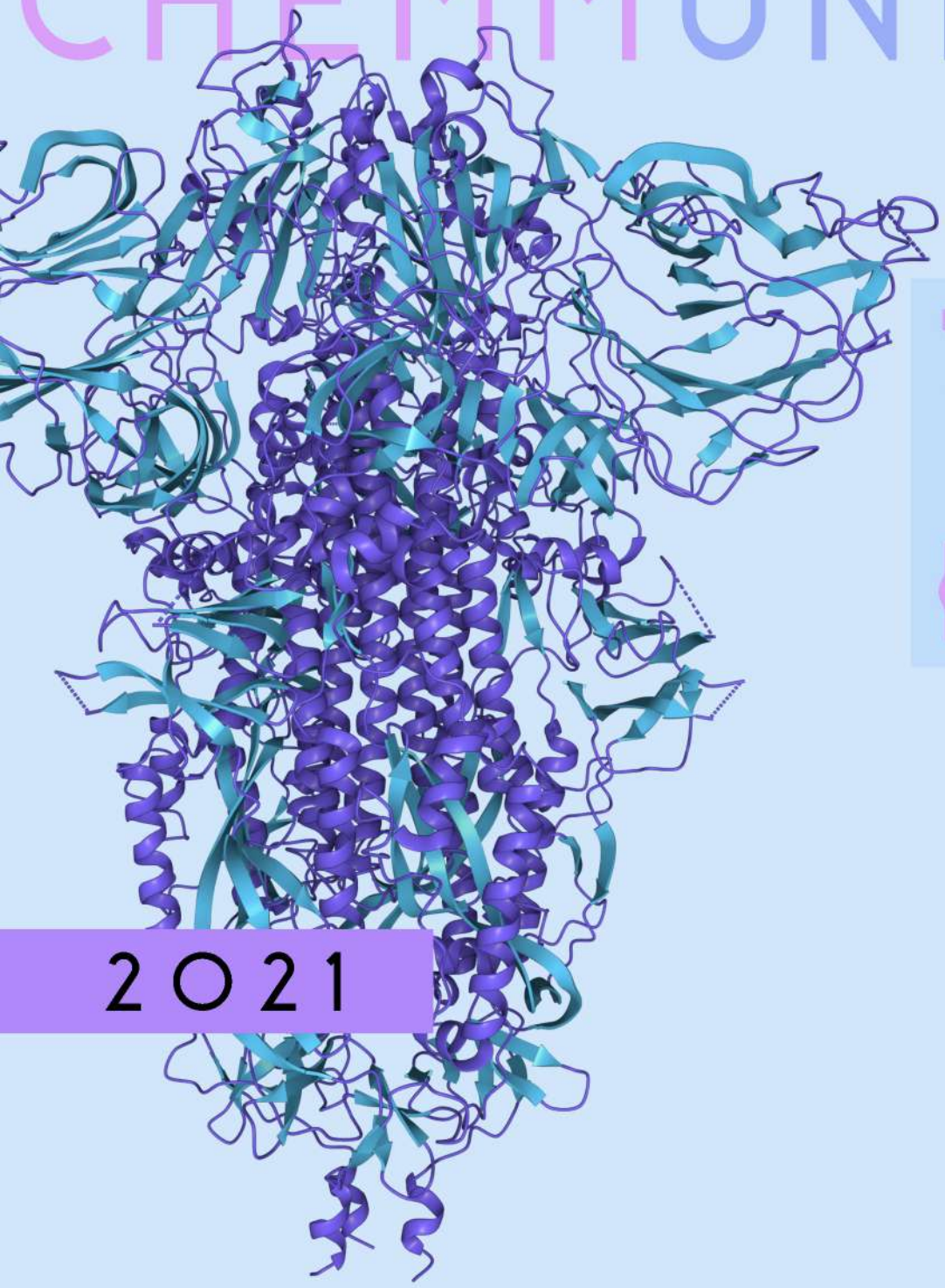
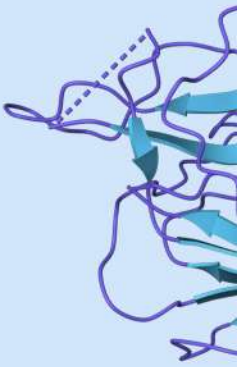
# CHEMMUNIQUÉ



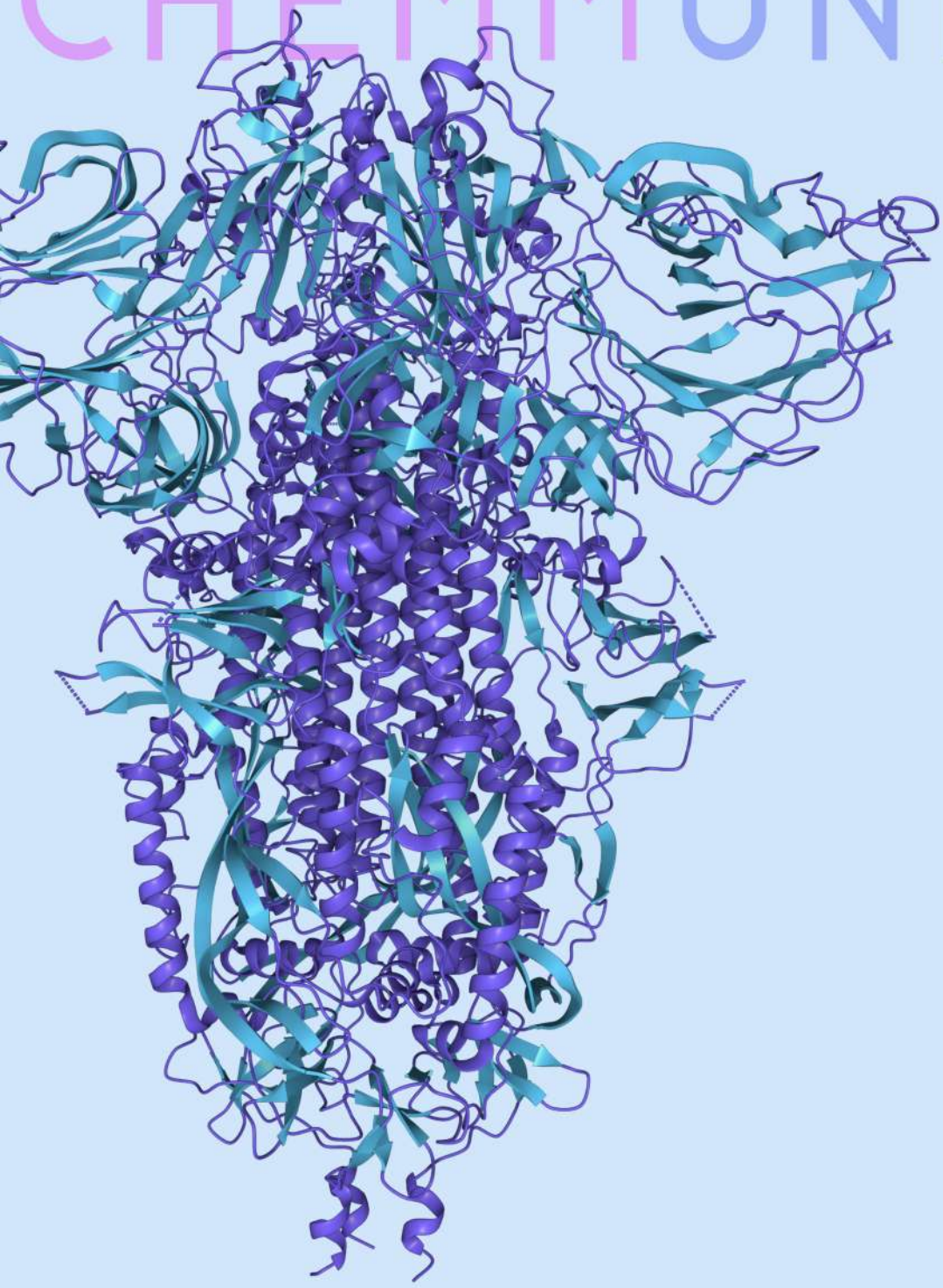
10TH EDITION

2021

***Department of Chemistry***



# CHEMMUNIQUÉ



# Chemmuniqué

## Edition 10

# Dean's Message

***-Dr. George Thomas***
***Dean of Sciences***

Chemmuniquē is the name of the newsletter published by the Department of Chemistry since 2011. It took birth in the auspicious 'International Year of Chemistry' (as declared by IUPAC). Since then, it has served the purpose of popularizing chemistry among students and faculty through a range of articles published every year. Now in its 10th year, it continues to bring good articles, poems and new information contributed by the students of chemistry.

Chemmuniquē is a platform for students to highlight their talents in the area of chemistry through articles, poems and thought-provoking ideas.

I wish to thank each contributor and the editorial team for their effort in bringing this issue of Chemmuniquē through their keen interest and effort. I am sure the students and faculty will carry this tradition forward.

# HOD's Message

*-Dr. Anitha Varghese*
*HOD*
*Department of Chemistry*

With another passing year. I am happy to see the publication of the 10 th addition of Chemmuniquē. It is indeed a great achievement by the department and its students to persistently bring eye-opening ideas about chemistry and its implication to sciences and human life in the form of articles. essays and poems which reaches the diverse crowd of our university. The impact that this newsletter makes on its readers is immeasurable. After all. this newsletter is an anthology from our own students and faculty that makes it relatable and relevant and adds value to the content at a personal level to both the authors and readers. This medium of communication and expression holds great potential for years to come. and I am very thankful and appreciative of everyone involved in making this edition possible.

# Editorial Team

## Staff Editor:
## Dr. Yamuna Nair | Associate Professor
## Department of Chemistry

## Student Editor:
## Rutwick Surya 6BCB

I am Rutwick Surya, in my final year BCB. I have been associated with the ongoing research on layered solids from the department of chemistry for the past 2 years. I have also been working on various research projects mainly in computational biology, phytochemistry and microbial biochemistry since my first year. While I truly enjoy engaging in this fascinating field of academia and research, I equally share my passion for literature, philosophy and strangely teaching! My own article in this newsletter is a fragment of my opinion on theoretical sciences and research in the form of a commentary to a paper that very recently held me captivated!

## Co-Editor:
## Sumukh SS 2MCHE

I am a first year Master's student, and a former BSc alumnus, here in Christ. I love me some quizzing, pop culture, Chemistry, music, memes, etymology, history, and trivia. I've been a part of CUQA, CUC, and the Cultural Team in my three years of BSc. There is a whole side of Chemistry that is interesting, which rarely gets talked about. And my article is a small contribution to the greater PR for Chemical Sciences. I strongly believe that knowledge is power! Be it in Puri and Sharma, or in my article which mostly has no bearing on the real world.

# Editorial Team

## Co-Editor:
## Ankush 6CBZ

Chemistry - and Science in general - gives us the tools to judge the truth value of any and all assumptions and thus, is of paramount importance and value to us in this contrasting age of information-misinformation. I am an advocate for Science and its Methodology. My article in the newsletter reflects my intention to improve awareness of misinformation: to eliminate it with Science. No question or opinion is exempt from the strenuous process of criticism. Apart from Science, and uselessly wondering about Science, my interests include reading, religion, philosophy, history, and what I'm certain will save the world: anime

## Co-Editor:
## Parithossh R 6BCB

I` am a final year student of BCB. I am pasionate about Scinece and art. I`ve always tried to bring these two things together. I aspire to communicate science through art. I am also a passionate Independent Filmmaker, Dancer and a beatboxer. I have been the Blossoms Media head for the School of Sciences for the year 2019-2020, which has given me a lot of experience in the field of designing. I am currently associated with Cambrionics life sciences for a Scientific Documentary. So in many ways i have started to follow my passion of communicating science through Art.

# Foreword

We have had a great experience being a part of the editorial team for the 10th edition of the Chemmuniquē. We are happy to share some of the key aspects of this year's annual newsletter with our readers and contributors. The scientific community over the past 15 or so months has seen nothing but eventful happenings across the globe. The pandemic-life has influenced, and in a way inspired work and literature across all disciplines, and we believe our newsletter is no exception. If the cover art featuring one of the most studied SARS CoV-2 spike protein (pdb:2GHV) for COVID-19 antiviral drug design doesn't justify our focus, then some of the articles on the viral biochemistry and drug discovery surely will.

It is however important to know that the very purpose of Chemmuniquē over the past decade had always been to communicate chemistry and inculcate it's interest to the society. It is crucial to ensure that this awareness and interest is independent of one's field of study. The very beauty of Chemmuniquē has been its interdisciplinary nature of articles, embracing perspectives and ideas of chemistry along with other physical and natural science and arts and humanities. This year is no different, and we are pleased to present write-ups in the form of essays, articles, poetries and critical commentaries from disciplines that are on the other end of spectrum but show fascinating relation to chemistry in both applied and theoretical. A subtle way to show our interest in relating chemistry and philosophy is evident from the alchemy symbols we used at the end of every article which are representative of earth, air, fire and water which various philosophical school of thoughts believe are the 4 fundamental elements that create all the existing materials in the universe.

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Finally, since Chemmuniquē is primarily a platform for scientific communications and expressions, we believe it is never complete without the authors themselves. We took this idea ahead to encourage the authors to make their opinions visible to the reader at a personal level by including more commentaries, autobiographical essays and their own research experience in our very own department. We also believe that the newly introduced author profiles at the beginning of all the articles allows the readers to further appreciate this perspective and connect with the writer as they read

-Editorial Team

# Share your Meal - your meal can heal

*"Deeply passionate about chemistry, I look for solutions to problems around us with the eye of a chemist. Starting from pollution to medical needs in a pandemic like the present one, I firmly believe the solution lies in the laboratory and research work. Water is the most indispensable source that we cannot afford to lose. I have presented a short account on water problems and Solutions from a chemist's eye."*

*-Prasiddha Nagarajan(2MCHE)*
*-Dr. SREEJA P B(Associate Professor, Department of Chemistry)*

"No one in the world should go to bed hungry. No one." said David Beasley. executive director. World Food Programme (WFP). WFP was the 2020 Nobel Peace Prize laureate. which is an American organisation exercising efforts to combat hunger and to prevent the use of hunger as a weapon of war and conflict. This strongly emphasises the need for sharing of food with the community and preventing hunger.

The coronavirus pandemic. has contributed to an upsurge in the number of victims of hunger around the globe. An extreme conflict has been reported in countries such as Yemen. The Democratic Republic of Congo. Nigeria. South Sudan and Burkina Faso where there is a dramatic rise of people living in the verge of starvation. Many organisations are taking efforts to

to combat this situation around the globe. But the most important thing is. the moral and ethical values pertaining to sharing of food with the needy should be cultivated and nurtured at the community level.

A report published by Food and Agriculture Organisation in 2015 stated that 194.6 million people in India are under-nourished and around 3,000 people die each day because of starvation and associated illnesses. To aid the needy in such situations of starvation. many organisations and individuals are working together at the community level. One such organisation in India was started by Harshil Mittal. called "Let`s feed Bengaluru". With around 4,000 donors and volunteers. the organisation collects and distributes home-cooked food to lakhs of people in five cities for which. Harshil Mittal was conferred the title of Rising Star at the Namma Bengaluru Awards.

The mid-day meal scheme. introduced by the former chief minister of Tamil Nadu in the state schools was directed at increasing the number of students engaging in education. Thus it is very obvious how food is a very strong missile to bring people together. The mid-day meal scheme brought children of different economic classes under the same bracket as they all fed on the same meal which reduced the prejudices that existed at that time between children of different creeds.

Sharing food is a global language which can bring people of different race. caste. language. sex. etc and wrap them under a common blanket of kindness. It doesn`t have to be done only on a large scale with anaim to feed lakhs of people. A simple act of feeding two others will suffice. Various awareness programmes are being conducted at school and college levels by inherent organisations like National Service Scheme (NSS). Young India (YI). etc that serve this purpose with excellent vigour and enthusiasm.

The only commodity that people say enough to is food. once it has filled their stomach and hearts. While other materialistic things like money. jewels. etc can increase a person`s greed. food still remain the foundation of need and kindness.

"Sharing food is not a person`s best quality. but his basic quality". Hence. this drive of sharing our meal with the needy should be given immense importance and continued with an aim to feed million others.

# Breaking the Glass Ceiling - 2020 Scenario

-Prasiddha Nagarajan(2MCHE)
-Dr. SREEJA P B(Associate Professor, Department of Chemistry)

Feminism, women empowerment, girl power, and many more have been a decade long fight for equality. Many articles and news pieces depicting the downfall of women and the inequalities faced by them are out there every day. Starting from simple household discrepancies faced by women, to unequal pay at the work environment, life sometimes proves to be unfair to them. Stating the reason of safety issues, tradition and duty, many women are denied opportunities to higher education, work, and a normal comfortable life style. In many scenarios we find that the reason for this extremity is not just men, but women themselves who have been brain-washed over generations into believing that they are the weaker section of the society and a denial of equality is nothing but normal. This situation started to face a breaking point since 2000 and has been fought against very strongly in the past 10 years.

And finally, this year, 2020, has reaped fruits for this decade long journey

and presented here are a few evidences for the same.

Since the Nobel prize was established. less than 60 women have been honored with the prestigious international award. But this year. four women have been awarded the Nobel prize. American poet Louise Gluck won the award for Literature. Emmanuelle Charpentier and Jennifer A.Doudna jointly won the award for Chemistry. and Andrea M.Ghez received the award for Physics. Four women winners in a single year is really an astounding victory on the race to equality. .Sharing food is not a person` s best quality. but his basic quality". Hence. this drive of sharing our meal with the needy should be given immense importance and continued with an aim to feed million others.

Louise Gluck

Emmanuelle Charpentier and Jennifer A.Doudna

Andrea M.Ghez

The United States of America has not had even a single woman in its presidential office. However. in 2020. Ms. Kamala Devi Harris has become the first ever Vice-president of the USA. The first step to equality in the White House has been achieved. Indians have the pride of saying that the world` s first prime minister. Mrs.Indira Gandhi. was from India.

Ms. Kamala Harris

On January 26, 2020, captain Tanya Shergill became the first Indian woman parade adjutant to lead an all-man contingent at 72nd Army day parade. She led an all-man contingent during the ceremonial Republic day parade at Rajpath, New Delhi. This very incident demolishes the claims so far that women are physically weak and men are the stronger part of the society. For the first time on republic day this year, an all-women bikers contingent of the CRPF (Central Reserve Police Force) made its debut and performed daredevil stunts during the parade. Till last year, only an all-male stunt performance was displayed. But this year, 106 women commandos on 26 bikes performed the daredevil stunts at a three kilometre stretch from Vijay Chowk to India Gate in New Delhi.

Captain Tanya Shergill

Stunts by Women on republic day

Kalpana Chawla

MS Subbulakshmi

At every juncture, women have proved their might for a very long time. From Kalpana Chawla, the first Indian astronaut to go to space, to winners of the Bharat Ratna award like M.S Subbulakshmi for her outstanding service to Carnatic music, many women have been striving to prove their worth. But many more women have been denied the opportunity to such achievements even though they possessed the potential to scale large heights. This is the sad part of this journey. Four women have won the Nobel Prize, but 4 million others have been denied access to even dream about it. Considering 2020 as the start for a better tomorrow filled with positivity and equality let us hope that there need be no more fights for equality. Let equality become the new normal instead of the fight for equality.

# THE QUANTUM WORLD

*"I feel science is just everything and I love studying science to decipher the hidden secrets ofnature. My hobbies are gardening, sketching, and preparing crafts from waste materials. I am a passionate teacher and want to pursue my career in the teaching and research field. I find chemistry very interesting and filled with wonders. Two quotes that always guides me are "If you can't explain it simply, then you have not understood it enough" and "The only job that doesn't have retirement is- BEING STUDENT""*

*-Sriraksha S,(2CBZ)*

Scientists always wanted to know what the atom looks like. and accordingly, there were many atomic models that came up to explain the behavior and the probable model of the atom. First came Dalton's atomic theory then Rutherford's followed by Bohr's atomic model. The most common picture that arises in everyone's mind after hearing the word atom is a small ball in the center with circular orbits around it shows how influencing the Bohr's atomic model was in those days. but fortunately or unfortunately it was later discovered that that was not how actually atoms are. Though Bohr did a phenomenal job explaining atomic spectra. the dual nature of matter and Heisenberg`s uncertainty principle shattered this model. Then to explain

their principles came the Quantum mechanical model of the atom.

The Quantum mechanical model has always been the most annoying and confusing for many students and also to me. When I tried to figure out the reason behind the wilderness that is built in the model I came across some interesting facts that make it what it is. And eventually found that knowing these facts helps people to enjoy and to have a better understanding of this model. Without a delay let us jump into the world of the tinies and the world of wonders and weirdness.

As illustrated before, the dual nature of matter is one of the limitations of the Bohr's model and a primary reason behind the need to develop this interesting model. So what does the dual nature of matter actually mean? Interestingly it was the Ph.D. thesis of a graduate student Louis de Broglie, who proposed that there is duality even in the matters as it was proven to be in case of the light. It means that a matter has two natures, one of a particle and the other of a wave. So then comes another question, what it is to be a particle or a wave? Let`s try answering this question. As soon as anyone hears the word wave I am pretty sure that the ripples of water when you throw a stone at it is the one that comes into our mind. So let`s explain the properties of the wave with this everyday phenomenon. Now imagine that you are near a clear pond and you throw a stone at it, what happens? you find concentric circles that are formed, right? Ok, now if I ask you what is the position of the wave what would you say? If you don`t have an answer then you are just thinking in the right direction because it`s not possible to know a particular position of a wave because the whole circumference of the circular ripple is the position of that particular wave you just cannot pinpoint a particular point as the location of the wave. Or it`s more often stated that a wave can possess more than one location at the same time. That`s it you have uncovered the first property that finding a location of a wave is just next to foolishness. And the rest are the things that are very simple, that is a wave can be characterized by its wavelength, frequency, and amplitude. So then what about a particle, just opposite to the wave we can determine the exact position or location of a particle, in fact, everything that you can locate around you like a ball, eraser, pen, etc is a particle. And just as you observe they have a fixed location and cannot literally exist in more than one location at the same time. Then, what

de Broglie proposed and that which Bhor couldn`t explain was the duality of matter that is in this case an electron behaves both as a particle and as a wave. When I first heard this I thought there was a printing mistake in my textbook, because just a while ago I mentioned " just opposite to the waves the particles are..... " then how can something act as both a particle and simultaneously as a wave? But the fact is that this is the thing that makes this tiny world weird and sometimes even nonsense to accept. And the fact that an electron that we are used to drawing as a small ball(which depicts particle nature) in all the other three atomic models behaves as a wave is what makes us feel uncomfortable towards the quantum model. Another thing that adds up to this feeling is that we are not used to seeing particles behave like waves in the so-called macroscopic world or our world or that world that we can see around us. This comes with a reason as suggested by de Broglie that momentum or more convincingly the mass is inversely proportional to the wavelength (depicts the wave character) of matter. So if you can imagine the mass difference between us and the tiny electron you can easily predict why the wave nature of matters that we see is very negligible. But let me tell you that if the wilderness of the quantum world did apply to our world it would have been very interesting, well you don`t have to pay anyone to imagine yourself!! If that happened you could enjoy an outing with your family in Shimla, attend your ESE in Christ University, write an article for Chemmuniqué in your home, and maybe give a lecture on Quantum mechanical models in London all at the same time, is that cool? Ok then coming back to our topic maybe now you would have understood how weirdly the electron might be moving around the nucleus as "a puppy without a chain" of course with some inward force by the nucleus which doesn`t let it all away but never like "small children' going" on behind the other in a fixed path. This was enough to shatter the Bohr's model with orbits and was replaced by the Quantum model with orbitals and probabilities.

Just at this time, I remember the words of some great scientist that " You are just not allowed to ask where the electron is, but what you can ask for is only the probability of finding it at a particular location at a particular time". This just straightway summarises what we have looked till now, yes you should

not ask where it is because as said earlier it behaves like a wave with no particular location. but you may ask is only the probability of finding it.

Though this model was very successful in explaining many things it was constantly criticized by some of the great physicists like Albert Einstein whose statement "Gods don`t play dies" is very famous. He also argued that it`s very vague and maybe that we seriously lack some important knowledge to fix them right so that they can be acceptable. It`s pretty interesting to note that even though we have a great idea of this now. the actual interpretation of this model is still debatable. Like some have the view of the existence of the parallel world when its implication enters the macroscopic world. where there may be your clone in another world. whereas somestill believe that Einstein was right that we are lacking something very important to fix this down. others think that there is much more weirdness in it than we can ever think of and some just believe as it is that the weirdness is an inbuilt nature of nature. These are some of the many interpretations that can be obtained through this model. Overall. hoping that you all enjoyed reading this as much as I did typing I would like to end with a very convincing quote that I happen to read somewhere that " If anyone claims to have understood the quantum world then either he is lying or he is a fool".

# ASTROCHEM-ISTRY: A Brief Introduction

*"I am Rakshith. I love reading philosophy, heavy fantasy, and swimming. I keep myself up to date with current affairs. I play video games occasionally. I am a leader and a team player. Astrophysics is my career of choice and I am working towards it.*

*- Rakshith V(4PCM)*

.Astrochemistry is the study of reactions of chemical constituents found in interstellar dust and outer space. This field of research is a combination of astronomy and chemistry. It involves researching the formation, interaction, and destruction of chemical compounds found in outer space, like interstellar clouds. Since molecules: presence and their abundance results from the passage of time and the physical environment, these molecules act as probes that give valuable insight into the physical environment and the

lifetime of the sources where they are found.

There are two types of molecules found in outer space, interstellar Complex Organic Molecules (iCOMs) and deuterated molecules (having one or more deuterium atoms). Over 150 molecules have been found, out of which approximately 50 have a chain of more than 6 molecules. There have been many databases to catalog and collect the different parameters required for the reactions to take place.

| N=2 | | N=3 | | N=4 | N = 5 | N = 6 | N = 7 | N = 8 | N = 9 | N = 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $H_2$ | AlCl | $CH_2$ | $C_2S$ | $NH_3$ | $CH_4$ | $CH_3OH$ | $CH_3NH_2$ | $HCOOCH_3$ | $(CH_3)_2O$ | $(CH_3)_2CO$ |
| CH | PN | $H_2S$ | OCS | $H_2CO$ | $SiH_4$ | $CH_3SH$ | $CH_3CCH$ | $CH_3C_2CN$ | $C_2H_5OH$ | $CH_3C_4CN$ |
| NH | SiN | $NH_2$ | MgCN | $H_2CS$ | $CH_2NH$ | $C_2H_4$ | $CH_3CHO$ | $HC_6H$ | $C_2H_5CN$ | $CH_3CH_2CHO$ |
| OH | SiO | $H_2O$ | MgNC | $H_2CN$ | $C_5$ | $H_2C_4$ | c-$CH_2OCH_2$ | $C_7H$ | $CH_3C_4H$ | $(CH_2OH)_2$ |
| $O_2$(?) | SiS | HNO | NaCN | l-$C_3H$ | l-$C_3H_2$ | $CH_3CN$ | $CH_2CHCN$ | $HOCH_2CHO$ | $C_8H$ | |
| HF | PO | $C_2H$ | $SO_2$ | c-$C_3H$ | c-$C_3H_2$ | $CH_3NC$ | $HC_4CN$ | $CH_3COOH$ | $HC_6CN$ | |
| $C_2$ | SH | HCN | $N_2O$ | HCCH | $H_2CCN$ | $NH_2CHO$ | $C_6H$ | $H_2CCCHCN$ | $CH_3CONH_2$ | N = 11 |
| CN | AlF | HNC | SiCN | HNCO | $H_2NCN$ | $H_2CCHO$ | $H_2CCHOH$ | $H_2C_6$ | $CH_2CHCH_3$ | $HC_8CN$ |
| CO | FeO | HCO | SiNC | HNCS | $CH_2CO$ | $C_6H$ | | $CH_2CHCHO$ | | $CH_3C_6H$ |
| CS | SiC | c-$SiC_2$ | | HCCN | HCOOH | $C_5N$ | | $C_2H_6$ | | |
| CP | | MgCN | | $C_2CN$ | $C_4H$ | $HC_4N$ | | | | |
| NO | | MgNC | | $C_3O$ | $HC_2CN$ | $C_5S$(?) | | | | N = 12 |
| NS | | AlNC | | $C_3S$ | $HC_2NC$ | $HC_4H$ | | | | $C_6H_6$ |
| SO | | HCP | $H_3^+$ | c-$SiC_3$ | $C_4Si$ | $CH_2CNH$ | | | | |
| HCl | $CH^+$ | $C_3$ | $HCO^+$ | $C_3N^-$ | HNCCC | $HC_2CHO$ | | | | |
| NaCl | $CO^+$ | $C_2O$ | $HOC^+$ | $H_3O^+$ | | c-$C_3H_2O$ | | | | N = 13 |
| KCl | $SO^+$ | $CO_2$ | $N_2H^+$ | $HCNH^+$ | $H_2COH^+$ | | | | | $HC_{10}CN$ |
| $N_2$(?) | $CF^+$ | | HCS$^+$ | $HOCO^+$ | $C_4H^-$ | $HC_3NH^+$ | $C_6H^-$ | | $C_8H^-$ | |

Fig: These are some of the compounds found. This table does not include the compounds containing isotopologues.

By studying the composition of the interstellar clouds, we can study the evolution of the cloud. This is done by analyzing the rotational or vibrational spectral data relayed from millimeter-wave telescopes on the ground or in space. The presence of molecules can be found using its spectrum with the background of a source like a star. This is found out using rotational spectroscopy. The molecule in the gas-phase absorbs radiation, which is used to increase its rotational energy (allegory to how atoms absorb radiations and their electrons are bumped into the higher energy level).

Their rotational energies are quantized for each molecule. This means each molecule can have fixed rotational energies, and they are discrete. The molecule then releases radiation, which appears as peaks in the spectral data. Studying this gives us indications regarding the presence and abundance of iCOMs and deuterated molecules. In our galaxy, both iCOMs and deuterated molecules have been found around protostars.

Some of the molecules detected were found to be very exotic and not commonly found on earth. They consist of both positively charged (HCO+) and negatively charged ions (like C 4 H-). Molecules containing unusual isotopes like deuterium, 13 C, 15 N, 17 O, called isotopologues, have been detected. All of the molecules detected with over 6 atoms were found to be organic.

One of the hurdles in this field is to study the reactions in the gas-phase, which take place under very low temperatures T 10K. These types of reactions are non-energetic and mostly exothermic in nature. Gas-phase reactions could not account significantly for chemical reactivity. It has been speculated that these molecules may also be found on the surfaces of interstellar grains. The gas-phase species condense on these grains to form ice mantles, which then react to form compounds.

This field is particularly new and is dependent heavily on the technology of our time. One of the greatest challenges is to detect Glycine in the interstellar medium, which would then provide the clue for the origin of life and further increase our knowledge of chemical kinetics in outer space. Glycine, along with many other amino acids, have been found in meteorites; all efforts to detect it in outer space have failed. Although Glycine has been interpreted to be present in the interstellar medium but owing to the limit of our detection technologies and the weak rotational transitions of Glycine, we have been unable to detect it.

Successful detection of prebiotic molecules in the interstellar medium, their evolution could give us an answer to the origin of life. In fact, Astrochemistry

be vital in explaining the emergence of life and whether life was synthesized on Earth from simple molecules or have been delivered to Earth.

With civilization` s progress. astrochemistry would provide an insightful tool to look into the reactions of molecules in space. which would help us synthesize certain compounds exotic to the terrestrial atmosphere. It would pinpoint places of certain molecules that could be used for certain purposes (for example. Tritium could be used as a fuel for fusion reactions). Although it is still in its very infant stages. astrochemistry is a fruitful field for anyone who has a love of the unknown.

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# When Quantum Mechanics Met Chemistry!

*"I am a 2nd year undergraduate student who is hoping to do research in theoretical physics. Although my marks hasn't been that good, I have never doubted my interest in Physics. Other than academics, I like to read novels and play chess. I also played a lot of sports till I joined Christ."*

*-Suhas S S(4PCM)*

It was 1927 when Fritz London and Walter Heitler combined their knowledge to open up a new era in chemistry with their paper on the hydrogen molecule. Around this time, the general theory of quantum mechanics was almost complete, but only few thought of applying it to chemical problems.

Fritz London was a German physicist and a professor at Duke University worked with some very notable personalities like Alexander Pfander, Max

Born. Arnold Sommerfield and Schrodinger. He wrote many theses and has written some astounding philosophical works which usually goes unnoticed. Some of his famous theories are the London dispersion force and the London penetration depth.

Walter Heitler was a German physicist who contributed to quantum field theory and quantum electrodynamics. He played a significant role in bringing chemistry under quantum mechanics. He was given fellowships at the Royal Irish Academy and the Royal Society of London and has received several medals. He was so determined to work in quantum mechanics that he convinced Schrodinger and Bjerrum to get him enough funding so that he can spend the funding which he received from the International Education Board at Zurich with Schrodinger and London.

When London and Heitler started working on how much van der Waals force arose from the interactions between two hydrogen molecules they had no idea what they would end up discovering. Their idea was to consider the molecule as composed as atoms which wasn't that different from the traditional view of molecules in chemistry but they adopted it by using the approximation technique known as "perturbation method", which was developed in celestial mechanics used in the old quantum theory.

They wanted to find what exchange would be there, if at all it did, when the interaction of the charges of two atoms was calculated. This exchange force remained a mystery for them and that this exchange was a new phenomenon which they said should not be interpreted in classical terms.

In view of the fact that the application of quantum mechanics led to the discovery that two hydrogen atoms form a molecule and not with two helium atoms is significant and truly shocking. "Such a distinction is characteristically

chemical and its clarification marks the genesis of the science of subatomic theoretical chemistry". reflected Pauling. who went on to play an important role in developing quantum chemistry. This paper had such an impact that Pauling and E Bright Wilson in their book on quantum mechanics for chemists. acknowledged it by saying "greatest single contribution to the clarification of the chemists` conception of valence ". This paper went on to be discussed in colloquiums across the world and had a huge impact on future theories. It was praised from scientists all over the world like Heisenberg. Lewis. Van Vleck and many more! Even looking at this paper from the current time gives us all the much needed inspiration. By thinking unconventionally. we may get solutions which could not be seen at all from other perspectives. We should try to solve problems with the help of concepts from all the fields which may lead to fascinating discoverie and open up new areas of research.

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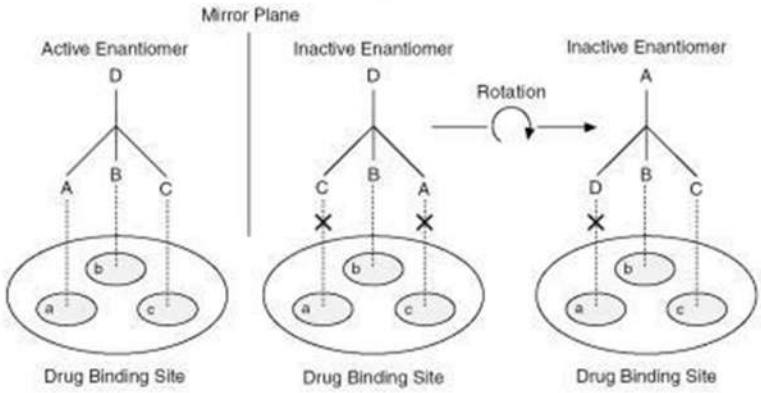
# Stereochemistry in Drug Making

*"My name is Edrea Mendonca and I have always been interested in the field of research. I always like to challenge myself in order to explore my extensions. I believe in being a lifelong learner and I strive to give my best in the works that I do."*

*-EDREA VALORA MENDONCA(6BCZ)*

Stereochemistry involves the study of the relative spatial arrangement of atoms within molecules. A chiral carbon is the one that contains four different groups. The presence of a single chiral centre leads to two possible enantiomers. Enantiomers are non-superimposable mirror images. The enantiomers of a chiral drug differ in their interactions with enzymes. proteins and receptors. These differences in interactions lead to differences in the biological activities of the two enantiomers such as their pharmacology. pharmacokinetics. toxicity. metabolism and immune response.

In the case of enantiomers. bonding interactions take place between the drug and the biological surface of the active enantiomer. whereas no such




"The active enantiomer has a 3-dimensional structure that allows drug domain A to interact with binding site domain a, B to interact with b, and C to interact with c. In contrast, the inactive enantiomer cannot be aligned to bind the same 3 sites simultaneously. The difference in 3-dimensional structure allows the active enantiomer to bind and have a biological effect, whereas the inactive enantiomer cannot.

interactions take place with the inactive enantiomer. Thus, the isomer with higher receptor affinity or activity is termed the 'Eutomer', and the one with lower affinity or activity is termed as 'Distomer'. For example, in Ofloxacin, the S enantiomer is more effective against Gram-positive and Gram-negative bacteria than the R enantiomer.

The active enantiomer has a 3-dimensional structure that allows the drug domains A, B, C to interact with the drug binding site domains a, b, c respectively, whereas the inactive enantiomer cannot be aligned to bind the same 3 binding sites simultaneously.

Pair of enantiomers also exhibit different therapeutic effects in the human body. For example, both enantiomers of the drug propoxyphene are available, dextropropoxyphene is used as an analgesic, and the other levopropoxyphene is used as an antitussive, which helps in relieving coughs. Study of enantiomers is very important because while one enantiomer is beneficial to the body, the other enantiomer can be highly toxic to the body. An example of this is the R and S enantiomers of thalidomide. Thalidomide tragedies occurred in the late 1950s, and this highlights the importance of stereochemistry. It was used as a sedative, hypnotic, and largely as a drug for treating morning sickness in pregnant women. Although the drug helped in suppressing morning sickness symptoms, it caused severe birth defects. The first birth defect was reported in 1956, and so the drug was withdrawn from

sale. Later in the 1960s, a link was suspected between the birth defect and the drug. Thalidomide contains a single chiral carbon and shows two enantiomers. R-Thalidomide alleviates morning sickness, whereas the birth defects were caused due to the presence of S-Thalidomide. In the human body, the drug thalidomide is racemic, and it was used a mixture of the two enantiomers. Even if it were used as the R enantiomer, the birth defects would have still occurred as the two isomers rapidly interconvert in the body to a 50 per cent mixture of both R and S Thalidomide. This disaster served as a driving force behind requiring strict testing of drugs before making them available to the public.

Although the enantiomers of chiral drugs have the same chemical connectivity of atoms, they exhibit differences in their pharmacology, toxicology, pharmacokinetics, immune response and metabolism. Therefore, when chiral drugs are synthesized, much effort is taken for the rigorous separation of the enantiomers. This ensures that only the biologically active enantiomer is present in the final drug preparation.

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# Structural Proteins of SARS-COV-2

*"I am Ankita . My interests lie in biochemistry and organic chemistry . I scored 95 % in my class 12th CBSE board exam in Chemistry and biology.I got an academic excellence award in my 11th grade . My article is about the structural proteins of SARS-COV-2 . I got interested in this topic as i am intrigued by the verocity with which the virus infects the human body . I wanted to know more about the biochemical aspects of the virus . "*

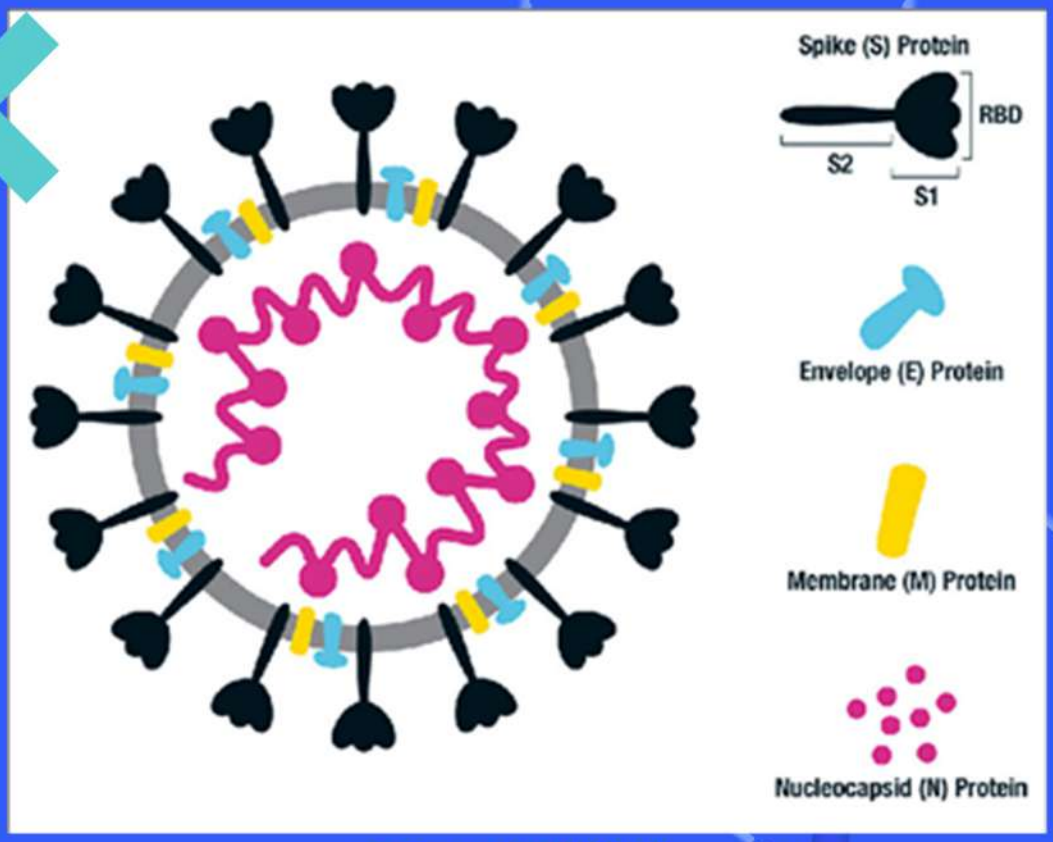
*-ANKITA NARAIN(4BCB)*

COVID-19 is a highly infectious disease caused by the novel virus of the corona family (SARS-COV-2). The first cases of this disease were registered in the Chinese city of Wuhan in 2019 but soon by means of human-to-human transmission. the virus spread globally causing a pandemic.

The genome of SARS-COV-2 encodes for at least 29 proteins. four of which are structural. The structural proteins include the spike (S) protein. Membrane(M) protein. Envelope (E)protein and nucleocapsid (N) protein.

## S PROTEIN OF SARS-COV-2

The S protein is a trimeric protein which is 600 Kda. It belongs to class 1

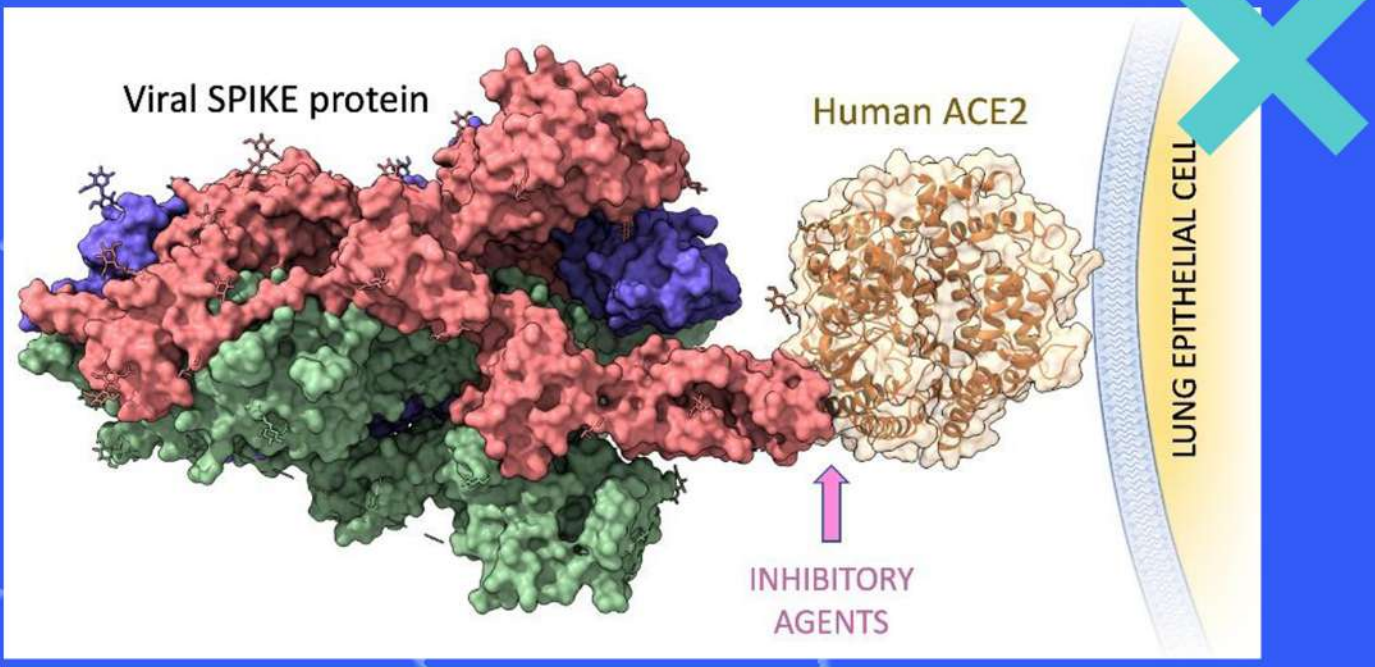



Genome of SARS-COV-2

Image courtesy: | Structure of SARS-CoV-2 and key antigenic components. Illustration of... | Download Scientific Diagram (researchgate.net)

fusion proteins. It is heavily glycosylated with 66 N- linked glycans. Its protomer contains S1 and S2 subunits and a single transmembrane (TM) anchor. This protein binds to the cellular surface receptor angiotensin-converting enzyme 2 through the receptor binding domain (RBD). The S protein gets activated due to the cleavage of S1/S2 by furin like protease. It undergoes a conformational change from prefusion to post fusion. The prefusion conformations of the S protein have three receptor binding domains (RBD) which display distinct orientations which are up or down. When the RBD`s adopt an up conformation, the receptor binding sites get exposed. When the S proteins are activated, structural rearrangements occur in which the S1 subunit is shed and the fusion peptide is inserted into the target cell membrane. After membrane fusion occurs, the S protein is transformed into a needle shaped post fusion form in which three helices are entwining coaxially.

The S 1 subunit contains heptapeptide repeat sequence 1 and 2. The S2 subunit contains a TM domain and cytoplasm domain.

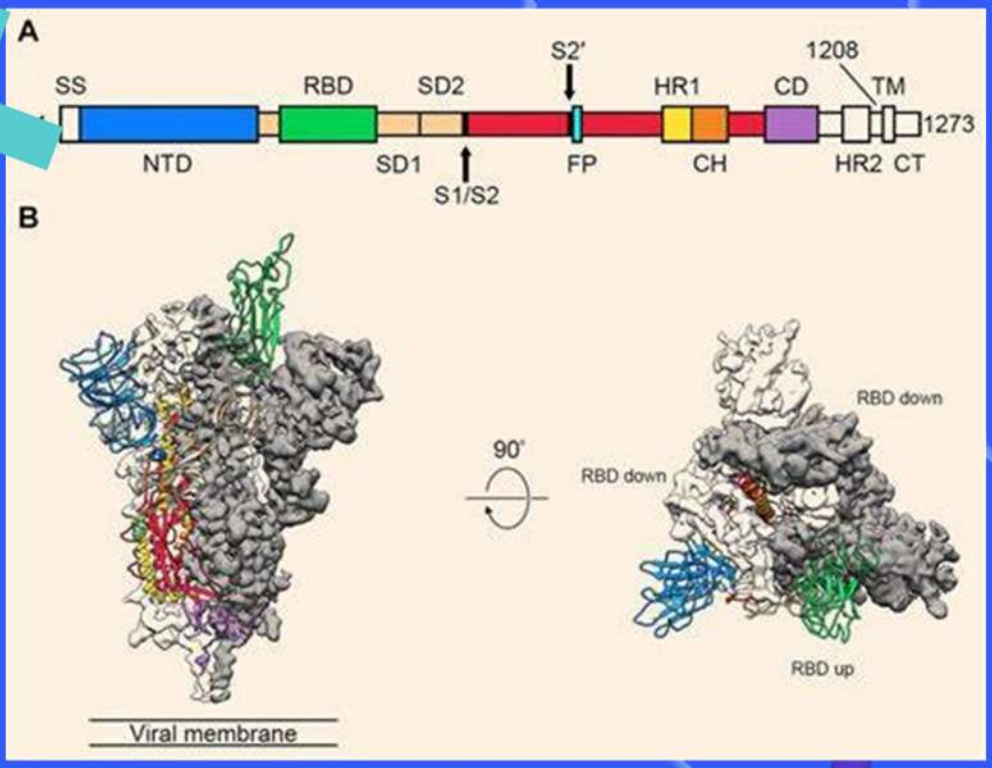



S protein of SARS-COV-2
Image courtesy: SARS-CoV-2-illo.jpeg (2760×1424) (lbl.gov)

## N PROTEIN OF SARS-COV-2

When SARS-COV-2 was analysed by cryo -electron tomography it was seen that RNP` s are organised into lattices under the envelope at nearly 4-5 nm resolution. The N protein of the virus was found to exist as a dimer in the solution on using techniques like static light scattering. size exclusive chromatography and small angle X ray scattering. The SARS-COV N protein has two distinct RNA- binding domains which include an N terminal domain and C terminal domain. The two domains are linked by a poorly structured linkage region (LKR) which has a serine/arginine -rich domain. The N terminal and C terminal domains are rich in β strands. The C terminal domain also contains short helices.

The N protein was found to contain coils (CD spectroscopy). The surface of the N terminal domain and C terminal domain are found to contain positively charged regions. The NTD domain appears to move freely in solution and the linker is partially extended in solution (SAXS modelling). The function of the nucleocapsid protein is to enter the host cell. bind to




N terminal domain and C terminal domain of the N protein of SARS-COV-2

the viral RNA genome and form the ribonucleoprotein core.

## M protein of SARS-COV-2

The M protein is what constitutes the viral shape. It is formed by three transmembrane domains and contains a small N terminal glycosylated ectodomain and C terminal endo domain. It folds into a dimer with two conformational changes. This promotes the membrane curvature to bind to a nucleocapsid.

## E protein of SARS-COV-2

This protein contains a N terminal ectodomain and C terminal endodomain with ion exchange activity. It facilitates viral assembly and release.

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# A critical commentary on Ma et al.. 2015 "Water nanodroplets surfing on layered graphene ripples"

*Student Editor*

*-Rutwick Surya U(6BCB)*

I have personally been associated with layered solids for the past 2 years. My work primarily concerns intercalation and adsorption characteristics of layered crystals. However, my interests were biased to crystals and intercalation for 2 major reason. firstly I have found void-based geometric manipulations of intercalation in crystals to posses more possibilities and parameters to explore than the diffusion of adsorbates on to them. Secondly, I wasn`t fortunate enough to have the infrastructure and technology that is demanded by monatomic layered solids whose interaction with adsorbates must be studied with critical molecular dynamics data since this mechanism is driven by physical and surface parameters in contrast to the easily predictable chemical parameters and interactions involved with crystals and layered salts. After reading this paper. the former scepticism has been greatly diminished.

This is a paper by Ming Ma and his team primarily from London centre for nanotechnology with collaboration by Gabriele Tocci from EPFL. Switzerland although the co-authors have collaborated from various labs of London as well as Switzerland. A distinct character of this paper that first drew my attention was the structure of the manuscript itself. I have always been an appreciator of the papers published before 1920s for their language and expression. The classic papers in both the theoretical and applied areas (although more so in the theoretical works for obvious reasons) had a tendency to beautify the subject through the confident use of abstract ideas. Their fluid narrative with loosely structured sections of the paper emphasized on work more than the result. A distinct style of drafting the paper in chronological succession of work conducted allowed room for publishing negative and failed results alongside the positive ones. This also allowed a reader to appreciate the growth of ideas and evidences within the span of a single work. While a majority of the modern papers have rationalized this format to narrow down the entire work to a fixed template (which understandably has been driven from institutionalization of research to accommodate the ever growing interest for applied sciences that more often than what is sane. diminishes the need for appreciation of science itself. ultimately causing the theorist`s curiosity driven science such as that of Feynman`s. extinct) papers such as this still keep the beauty of theoretical sciences alive.

The paper describes the investigative results concerning a novel mechanism of diffusion of adsorbates (primarily water nanodroplets of 2-6nm in diameter) on graphene layers that is suggested to show a surfing dynamics in contrast to the previously generalised vibrating or static surfaces of the adsorbent. The study is extended a step further to demonstrate how the diffusion kinetics of this surfing molecular model is much faster (exponentially) than the latter. The major instrument used in this paper is computational molecular dynamics analysis which in my opinion is perhaps the single most versatile utility for study of materials as well as molecules of biological importance. The output of molecular dynamics could be statistical models and graphs as well as simulated animations of a molecules` interactions and behaviour in an environment predicted against a few tens to hundreds nanoseconds. This paper also presents its data from field ion microscope, helium atom scattering and scanning tunnelling microscope. The knowledge of molecular dynamics on surfaces is fascinating for several reasons ranging from the challenge of elucidating an elegant mechanistic model that is convincing to the diverse nature of these molecules and atoms on the surfaces they interact, be it searching for the active site on a catalyst or hunting a precise lattice point to bind to in a growing crystal. The diffusion dynamics were previously considered to be on a stationary vibrating surface which provided the thermal energy for diffusion. The motion of the adsorbate was believed to be linear from one lattice point to another. However, this model is disproved by Ma et al. for thin layered solids such as graphene. The work was carried out with complete awareness of the pre existing knowledge about the presence of ripples on graphene surfaces almost a decade before this paper was published. It is interesting to note how no studies were conducted in this gap of time due to logical presumptions all of which were severely contradicted by this paper. For instance the previous diffusion model that didn`t factor in the surfing motion suggested that weakly bonded adrosbates such as $C_{60}$ diffused much faster than strongly bonded ones like water. However, this paper suggested the exact opposite.

The ripples on graphene sheets occur either due to thermalor mechanical

The bending and streaching modes of graphene are anhormonically coupled in thermally induced ripples and will remain the primary interest of this paper. Some of the physical parameters of these ripples that have been explored in the paper are as follows. The root mean square height of the ripples is exponentially proportional to the size of the graphene sheet by a power law relation that restricts the wavelength to the size of the sheet. The amplitude of ripples is several angstroms high and its life time remains in the range of picoseconds to few nanoseconds. In fact the lifetime of smaller ripples is shorter than those of larger amplitude. However the author suggests possible deviation between these observations and the reality due to constraints on the graphene sheet being held by clamps for experimental observations.

The water droplet was found to displace the carbon atoms from its expected lattice point by less than O.O2 nm. However, the diffusion of the droplet itself (quantified with diffusion coefficient D) greatly depends on the size of the droplet accounting to the contact surface (or what I actually believe in this dynamic simulation is the number of atoms of water that is in contact with and displaces the carbons of graphene as it surfs through the ripples, primarily because the model discussed in this paper considers nanodroplets which would definitely contain only hundreds of water molecules). However, the authors comment that the D value obtained was unexpectedly large by few order of magnitudes (or in simpler terms the diffusion is faster due to the surfing) in comparison with other diffusion systems in terms of both the adsorbent and adsorbate. To evaluate this result better, the authors also conducted a comparative diffusion study with $C_{60}$ in terms of a major parameter revisited several times in this paper which is the relation between water nanodrplets to the amplitude of ripples on graphene surfaces. Most of the interest for this amplitude relation is due to the fact that the ripples are dynamic and not static which is a key factor causing the surfing of water droplets along these ripples. However, while comparing the amplitude (A) to diffusion coefficient (D) relation for the graphene-water system and graphene-$C_{60}$ system a very interesting non-monotonicity was observed. While D increased with A in the former, it decreased with A in the latter. In other words, ripples on graphene assisted the diffusion of water but resisted the diffusion of $C_{60}$. The answer to this inconsistency lied in the probability

density model of these molecules occurring on the crests and troughs of the graphene ripples. The water molecules showed high coupling to the graphene surface and had distinct preferences of the surface it habited (or what the authors called the valleys) and in this way, the ripples essentially carried the surfing water molecules and their coupling was the key cause (or mechanism) of this abnormally fast diffusion. This was not the case with $C_{60}$ which showed 40% less coupling, allowing the ripples (in terms of its amplitude) to just bob the entity up and down instead of carrying it along the surface (surfing). Ironically this also contradicts the previously expected contrasting behaviour which was wrongly assumed accounting for the masses (it must be noted that the water molecules cluster to give 170% heavier droplets than $C_{60}$) and the force of binding of the adsorbate to the surface (assumed to be static) being inversely proportional to diffusion rates. It must also be noted that in those materials that do not pose a preference to habit a specific region of the surface (such as $C_{60}$) although shows a greatly slower diffusion, is in fact favoured by those surfaces that has the least coupling affinities because the smaller coupling would allow the molecule to diffuse instead of unwillingly bobbing up and down with the ripples.

While this paper is perhaps a pioneer for diffusion, there have been works on transport of water in carbon based nanotubes. The relevance of this model has wide potential applications due to the ever growing interest of graphene water systems in the present decade with large number of work revolving around properties such as reactivity, structure and wettablity of graphene to nanodroplets of water. However on a personal bias, I would like to conclude this commentary not with a portal for potential applications but to take a step back and appreciate the elegance of this model, and more importantly the amount of scrutiny and creativity put into testing an otherwise easily ignorable phenomenon. The beauty of this work lies not in the experiment design itself but the fact that these experiments were considered worth designing in the first place.

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# Nuclear Waste. an elixir of life?

*"My name is Sumukh V Makam, and I love Nuclear science. I like gathering the latest innovations irrespective of the field and building a new world in my head using those innovations. Apart from science and technology, I am a huge follower of the Cricketing world."*

*-Sumukh V Makam(4PCM)*

Nuclear waste or radioactive waste is the byproducts from nuclear-driven plants or industries, mostly made up of Uranium and highly hazardous. The estimation from 2018, indicates that there are approximately 35 million m3 of solid radioactive waste in the global inventory, which raises the concern of its disposal.

## What Are Radioactive Isotopes?

Radioactive isotopes are isotopes of an element with an unstable nucleus.

The most common example of this is Uranium. Uranium-238 is stable and is available abundantly. a small fraction of available Uranium is Uranium-235 (which has three neutrons less than $^{238}U$) which is unstable and thus radioactive.

## Can Radioactive isotopes save lives?

Radioactive isotopes have significant implication in the field of medicine. It is used for various kinds of imaging and is also used in cancer therapies. For example. technetium-99m has numerous applications. In one of them. it is injected into the subject's body. then SPECT (single-photon emission computed tomography) is used for imaging the radiation. This process helps in studying the blood flow or tissue growth in the body. Actinium-225 is an isotope which emits alpha-particles which can be used to disable cell growth. This kind of isotopes is used to treat cancer and hyperthyroidism. Iodine-131. samarium-153. and phosphorus-32 are also used for similar therapies.

## Extraction. a problem?

Most of the radioactive isotopes used in medicine have low or no occurrence in nature. As a result of which there is a shortage of these life-saving isotopes. Most of the medical radioactive isotopes are produced in a cyclotron (an accelerator) wherein the stable isotope is bombarded with protons or in a reactor where the isotope is bombarded with neutrinos. Carrying out such a process is not just technologically demanding but also is highly expensive. So. today. there are very few organizations who produce such radiopharmaceuticals. and if any of these organizations cease the extractions. it will cause a shortage for these pharmaceuticals.

## A new way?

The problem with the extraction of Radioactive isotopes can be solved using nuclear waste. which is available in huge quantities. Usage of nuclear waste

can resolve the issue of lack of availability of the rare elements (and their rare isotopes). It also makes way for recycling and thus addresses the concern of disposal of nuclear waste.

Currently, when Isotek (partner of DOE in the disposal of radiowaste) receives material for disposal from DOE (Department of Energy) of USA, some of the Uranium-233 in the waste is decayed to Thorium-229, which is the source of Actinium-225 (a medical radioactive isotope). Isotek, as a process of disposal dissolves this waste in nitric acid, which converts Uranium into less radioactive Uranium nitrate. Then this is run through ion-exchanger to isolate 229Th selectively. Then this is shipped to a various private organization for extraction of Actinium-225.
ORNL laboratory is one such company: they use a method developed by Saed Mirzadeh and Rose Boll in the 1990s, which highly depends on the half-life periods of Uranium-233 and Thorium-229, which is 160,000 and 8,000 years respectively. Due to the very long half-lives of these species, the production of Actinium-225 is small and is not enough to meet the requirements.
TerrapPower, another private company, has borrowed 15 barrels (each weighing up to 350 Kg) of nuclear waste from Isotek and planning to mine radioactive isotopes through a new method they call "Milking the Thorium cow". This process of milking/extracting radiopharmaceuticals is more efficient from previously existing methods. TerraPower hopes that mining the waste this way will yield between 200,000 and 600,000 doses of 225Ac a year, 100 times the number of doses currently available globally.

The step taken by the TerraPower has created a new avenue for research in the recycling of nuclear waste. One day, this may lead us to a world where nuclear waste will really be called an "elixir of life".

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# Recent advances in g-$C_3N_4$ based ZnO nanocompo-site

*"Currently pursuing Masters in chemistry at CHRIST (Deemed to be university), Bangalore. I did my bachelors at CHRIST in PCM (physics, chemistry and mathematics). I have great interest in the field of CHEMISTRY. I always look for wonders that chemicals bring on. I have enthusiasm towards my budding research career where I am pinned to Heterogeneous catalysis, nano science, materialscience, electrochemistry and many. My side-lines, I love to do gardening, cooking, I make lots of craft stuffs."*

*-Madhushree R(2MCHE)*

In recent years, metal-free graphitic carbon nitride (g-$C_3N_4$) photocatalyst offers intriguing prospects in the area of environmental purification and remediation. Typically, g-$C_3N_4$ is a two-dimensional layered polymeric semiconductor consisting of tri-s-triazine units, which are connected by N atoms to construct a planar grid structure. Owing to its facile preparation procedure, unique electronic structure, and high physicochemical stability, g-$C_3N_4$ has been widely employed in environmental pollution abatement. Few properties of graphitic carbon nitride like it being a non-toxic, chemically stable, conjugated polymeric material has become a point of interest recently, for the development of various photocatalysts because of their tuneable band gap of 1.8-2.7 eV to absorb visible-light radiation for efficient degradation of harmful dyes. Metal-free g-$C_3N_4$ has found enormous application in the elimination of organic pollutants from industrial wastewater using visible light. Currently, ZnO structures such as nanosheets and nanoplates have attracted attention for showing promise in areas such as photocatalysis, environmental and semiconductor applications. Zinc oxide exhibits properties such as high electron mobility, exciton binding energy of 6O meV, high redox potential, and a direct band gap of 3.2 eV. These can be improved upon by doping/co- doping with various metal/non-metal ions, combining with other semiconductors, surface sensitization with dyes or metal complexes etc.

Because of these extraordinary properties both ZnO and g-$C_3N_4$ can be employed as in one system and investigate its properties as a single binary system. A trial for the ternary system can be done viewing at its increased photocatalytic properties. Here, I prepared a binary nanocomposite g-$C_3N_4$/ZnO via a simple, inexpensive method and characterized. This heterostructure showed efficient visible light harvesting and charge separation properties which helped in achieving high photocatalytic performance towards the degradation of MG from water bodies. The reaction obeys pseudo first-order kinetics and the rate constant was calculated at O.O329 min 1. The catalyst exhibited good stability and recyclability for up to five cycles. The heterojunction formed by g-$C_3N_4$ and ZnO exhibits direct Z-scheme mechanism in the photodegradation process and is a promising

semiconducting material for the purification of dye infested water through mineralization

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# An Outlook on MXenes: A Novel Nanomaterial and Its Current Trends

*My name is Meghana V. My areas of interest include materials science and food chemistry. I am currently pursuing research in MXenes based photocatalysis. Apart from education, I've practiced Carnatic Shashtriya Music, I love sketching and cycling."*

*-Meghana V (4PCM)*

*"My name is Sneha Ravi Kali. I am keen to study and work on various topics in cosmetic chemistry, green chemistry, and radioactive chemistry. I am currently pursuing research in MXenes based photocatalysis. Apart from education, I pursued karate for most of my childhood."*

*-Sneha Ravi Kali(4PCM)*

MXenes are a family of 2-dimensional inorganic compounds that are composed of carbonitrides, transition metal carbides, and nitrides. Research on such 2D materials significantly increased since the discovery of unusual physical properties of graphene in 2004. The development of clean energy to replace traditional unsustainable fossil-fuels has gained tremendous interest due to our ever-increasing energy requirements and the environmental crisis related to it. Despite incredible achievement in this area, exploring and developing an efficient electron extraction co-catalyst, which is cost-effective and driven by sunlight, is an ongoing search.

A handful of synthesis routes of MXenes have been discovered, each having its own advantages and disadvantages. The choice of a synthesis route for a particular MXene depends upon the MXene about to be synthesized and the desired properties. A conventional way of synthesis of MXenes is through MAX phases. These MXene precursors (MAX phases) have the stoichiometry of $M_{n+1}AX_n$ (n=1,2 or 3), where 'M' represents d-block transition metal, 'A' is group IIIA/IVA elements and 'X' is C/N. Some examples of MAX phases are $Ti_3AlC_2$, $Ti_4AlN_3$, $Nb_2AlC$.

Selective etching of A layers from MAX phases with aqueous fluoride-containing acidic solutions has been predominantly used to synthesize MXenes. This can be done using aqueous or by in situ formation of hydrofluoric acid. MXenes can also be intercalated using aqueous ionic compounds, such as halide salts or metal hydroxides.

The morphology of raw MXene powder obtained through selective acid etching of MAX phases normally features an accordion-like multi-layered structure. The crystal structure of MXenes normally inherits the hexagonal atomic lattice P63/mmc of their MAX parents. Where 'X' atoms occupy the octahedral interstitial sites and M atoms are hexagonally close-packed. The various structures of MXenes depending on the value of 'n' includes $M_2XT_x$(having AB stacking with hexagonal structure), $M_3X_2Tx$ and $M_4X_3T_x$(having ABC stacking with face-centered cubic structure). The different types of MXenes are carbide($Ti_2C$), carbonitride($Ti_3CN$), nitride(Ti4N3), and metal nitride-based(ammoniation of carbide-based MXenes). Six possible structures of MXenes as given by atomic-resolution STEM, HRTEM and EELS include structures having mono-M elements,

ordered out-of-plane & in-plane double-M elements, solid tsunami, one of the solutions, ordered and randomly distributed vacancies. Different types of structures of MXene such as MXene quantum dots, nanoribbons, porous MXene, aerogels, nanofibers, nano-flower like 3D MXene are being synthesized in the recent decade.

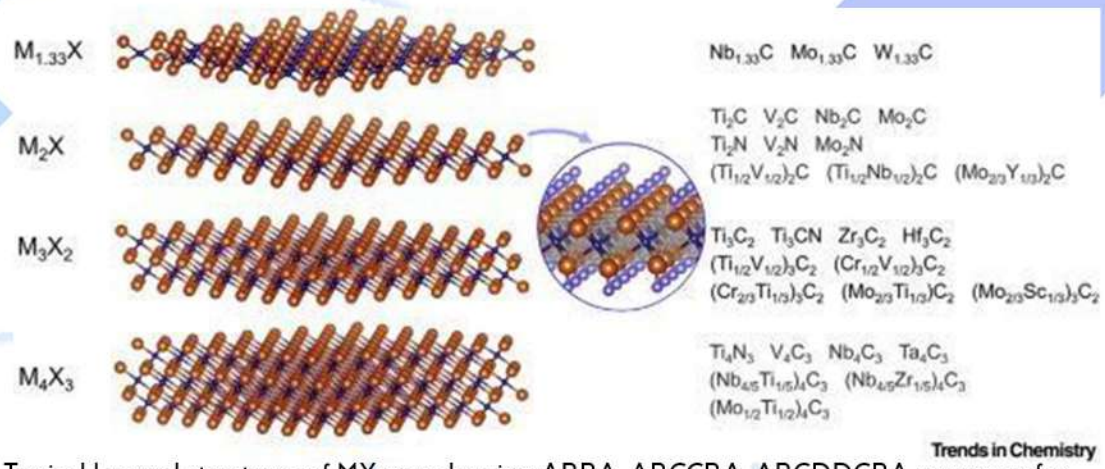


Fig: Typical layered structures of MXenes showing ABBA, ABCCBA, ABCDDCBA sequence for Mn+1Xn, n=1,2, and 3, respectively.
[Source: https://doi.org/10.1016/j.trechm.2019.04.00 61

## Properties

The special ultrathin 2D structure, presence of abundant exposed active sites, large specific surface area, high quantum efficiency, hydrophilic surface terminations, advanced atomic utilization, intimate interface contact area, excellent surface energy, high photoactivity, physicochemical stability, recyclability, superior separation efficiency, nontoxicity, d-spacing, lateral size, unique surface functionalized groups and environment-friendly characteristics makes MXenes a perfect catalyst support. The distinct properties of these MXenes are derived from the unusual combination of ceramic behavior (low density, high hardness & excellent corrosion resistance) and metallic behaviors (good machinability, high thermal & electrical conductivities). These properties are due to the presence of primary M-X bonds that have a mix of ionic, metallic and covalent nature.

## Applications

MXenes have been successfully used in alkaline-ion based batteries. catalysts for $H_2$ evolution from water. fabrication of supercapacitor. oxygen evolution reaction. water remediation. biosensors. photovoltaics. oxygen reduction reaction. manufacturing lithium-ion battery. $N_2$ fixation. degradation of organic/synthetic pollutants. light-to-heat conversions. energy electrodes. energy storage. gas separation. cell imaging. anti-fouling agents. electromagnetic adsorption and shielding.

The rich but unexplored family of MXenes with the unique combination of morphology and properties make them attractive nanocomposites for various applications. Their broad range of applications notifies us to invest a generous amount of time and effort in all of its applications. both commercially and in research.

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# Chemistry in Popular Culture:

*Co-Editor*

*-Sumukh SS (2MCHE)*

In a world where popular science has been dominated by fanatics of physics and astrophysics, chemistry has carved out a small but identifiable niche for itself, with a few strong, but sparse references in pop(ular) culture.


One famous, easily identifiable reference would be that of the football. The structure of the football is akin to that of $C_{60}$ - Buckminsterfullerene. The truncated icosahedral pattern of the Adidas Telstar ball, which was introduced in the 1970s, is identical to the structure of Buckminster fullerene, earning the latter the moniker ..

"Buckyball". In my opinion. "Buckminsterfullerene" is a too long a name for a structure so recognizable. Named after Buckminster Fuller. the American architect who designed geodesic domes. Fun fact: Buckyballs are not identical to geodesic domes. Buckyballs have hexagons and pentagons. whereas these polygons are further divided into triangles in geodesic domes. In fact. Buckyballs are a geometric example for a naturally occurring Goldberg polyhedron. Personally. I do not appreciate having a molecule named "Goldberg-ene" or some similar asinine name. Given that the $C_{60}$ buckyball molecule was discovered in a football-hungry Britain. one wonders why it wasn`t just named "football-ene" instead of the verbose "Buckminsterfullerene".

## Breaking Good for Chemistry

Fans of physics and astrophysics have Neil DeGrasse Tyson. Carl Sagan. and The Big Bang Theory for their dose of popular physics. I say. let them have it! With all due respect. they are no match for the best television show to have ever existed (sorry Game of Thrones. you really lost the plot in the final season) Breaking Bad. the show is as addictive as the psychoactive drug that is depicted - crystal meth/methamphetamine. The show is known for having chemistry of acceptable accuracy - especially vis a vis the preparation of the drug. You obviously cannot have an accurate representation of methamphetamine synthesis due to safety concerns. Nevertheless. the extent to which the show`s creators went to achieve the scientific accuracy is commendable. There have been multiple allusions to chemistry barring the methamphetamine - mercury fulminate or fulminated mercury. and the poison ricin being the more enticing ones.

Walter "Heisenberg" White. the Nobel-winning-school-teacher protagonist. decides to cook crystal meth to pay for his chemotherapy. He throws

fulminated mercury [$Hg(CNO)_2$] - a primary explosive on the ground to blow up a drug dealer's headquarters. whereas the highly potent toxin ricin was used in similar circumstances. Ricin is produced in the seeds of the castor oil plant Ricinus communis. Such examples of chemicals are enough to incite the curiosity of the viewers to develop an affinity towards chemistry.

## Wildfire tamed.

Historically. Greek fire was used by the Byzantine Romans (yes. Romans. Not Greeks) in the 7th century AD as a form of naval chemical warfare. Greek fire was achieved by using a liquid combustible compound which was propelled onto ships by flame-throwing weapons. and it was inextinguishable by water. This weapon is believed to have contained naphtha - a compound now found in napalm - another incendiary weapon (a weapon used to start a fire). This historical weapon was adapted to the small screen by the HBO series Game of Thrones as wildfire. Wildfire is depicted as a liquid that could float on the seas. which would explode with such a tremendous force that the resulting fire was inextinguishable by water. While the show depicts Wildfire to be an explosive that could only be stored in jars or spread out on water. Greek fire could be contained in small grenades which could be thrown onto enemy ships.

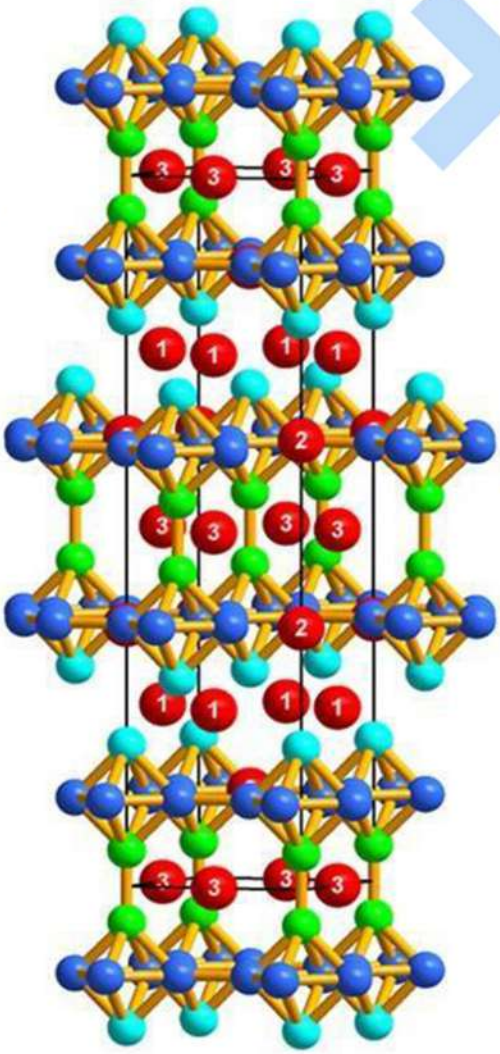
## Not-so-truth serum

Veritaserum is a potion brewed in the Harry Potter Universe. that can magically make a person speak the truth. The real-world analog to Veritaserum is the "truth serum" - a collective of psychoactive compounds that can be used in interrogations to extract truth from non-compliant subjects. Despite what the name suggests. truth serums do not actually make a person magically speak the truth. They just make the subject more talkative. leaving them susceptible to reveal more than what is intended by them - and as a side effect. the truth does spill out. One of the most widely used "truth serums" in crime shows and action movies is the compound Sodium pentothal. It has been marketed by popular media as a wonder

chemical that can make people speak the truth and bring interrogations to a premature end. As fantastic as that might be, there is another truth serum that is widely available to the public – ethanol. One of the side effects of consuming alcohol is running your mouth off a lot. This is the general effect that Sodium pentothal and other truth serums have on the nervous system. They don`t seem so impressive now, do they?

## BaZnGa!

Dr. Sheldon Cooper is a revolutionary, universally beloved character from the universe of The Big Bang Theory. Naturally, when Na Hyun Jo, a graduate student at Iowa State University heard his catchphrase "BAZINGA!", she had a moment of inspiration. After going through existing literature, she realized that there wasn`t a ternary compound synthesized that was made up of Barium, Zinc, and Gallium. She published the paper "Growth and characterization of BaZnGa" with the corresponding author Dr. Paul C Canfield a massive fan of the show as well. Unfortunately, the ternary compound BaZnGa did not yield any remarkable properties of superconductivity or of quasi-crystalline nature. However, Dr. Canfield is not disillusioned by the setback. He claims that the novel discovery of a crystal of Barium, Zinc, and Gallium should be the key takeaway, and that research explores the unknowns of which we might not be aware. This is one of the very few ways that popular media has influenced science as we know. [1]



## Fallacies!

Obviously, not every media house takes the care to actually check the scientific accuracies involved in their productions. As Indians, we have been used to the malarkey fed to us through the action scenes which violate all laws of science. Regardless, every scientific tidbit presented to us in movies or TV shows should be taken with a pinch or two of salt. For example, in the 1983 James Bond movie Octopussy, Q gives James Bond a pen containing Aqua Regia and tells him that the liquid can dissolve all metals. Aqua Regia is a very corrosive chemical, and is known to dissolve noble metals like Gold and Platinum. But, it still cannot dissolve Silver or Ruthenium! This is a minor fallacy that can be forgiven.

The Marvel Cinematic Universe drew criticism for its handling of time-travel in its 2019 movie Avengers: Endgame. But a chemical fallacy first arose in Iron Man 2 when Tony Stark gets stabbed with an injection of Lithium dioxide to get rid of symptoms of Palladium poisoning. Lithium dioxide ($LiO_2$) does not exist. Lithium is an alkali metal which can attain a maximum oxidation state of +1. So the only oxide of Lithium that exists is $Li_2O$.
These are only two of the more high-profile cases of chemical inaccuracies in popular culture. There have been more heinous crimes committed against the scientific community by the makers of TV shows and movies. In spite of our pursuit for artistic integrity and creative freedoms, my plea would be to ensure that scientific accuracy is not sacrificed.

## References:

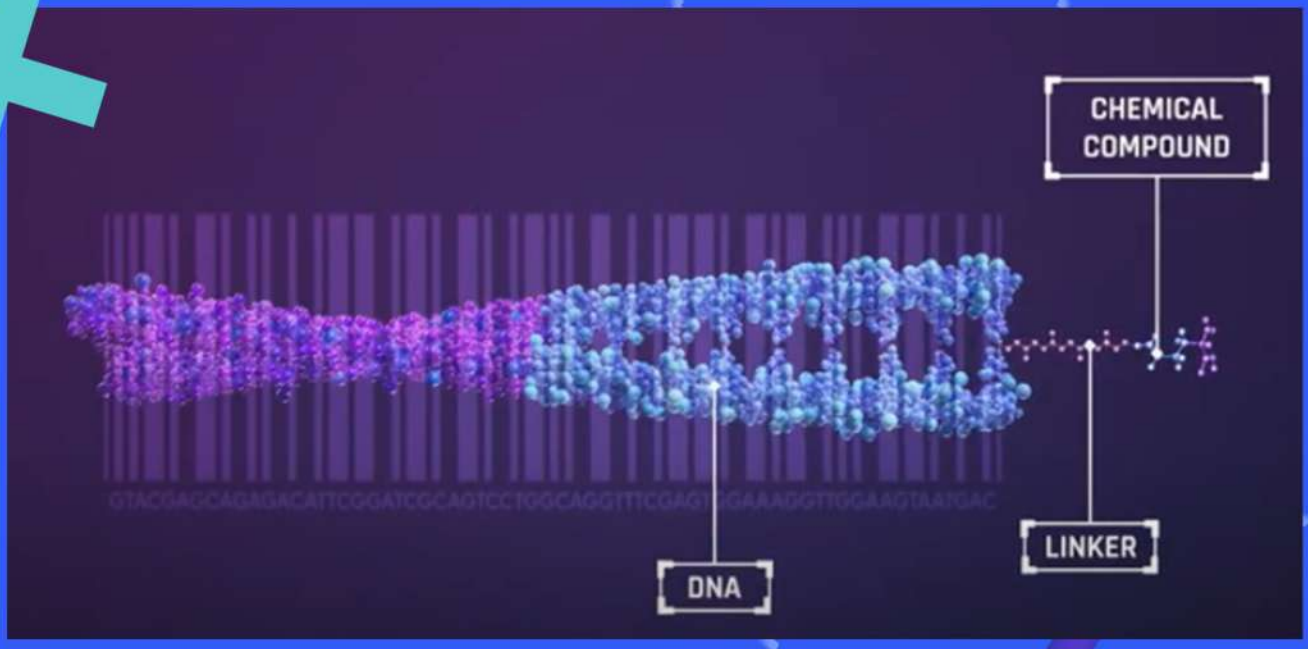
[1]N. Jo et al., "Growth and characterization of BaZnGa", Philosophical Magazine, vol. 97, no. 35, pp. 3317-3324, 2017. Available: 10.1080/14786435.2017.1380861.

# Decoded: DNA Encoded Chemical Libraries (DELs)

*"I am a 2nd year undergraduate student who is hoping to do research in theoretical physics. Although my marks hasn't been that good, I have never doubted my interest in Physics. Other than academics, I like to read novels and play chess. I also played a lot of sports till I joined Christ."*

*-Karen Jessica S(4BCZ)*

Fundamentally, what is the difference between chemistry and biology? For this, we need to examine the distinction between chemical molecules like drugs and biological molecules like DNA. The former does not carry information in the form of a code by which it can be identified and are unable to replicate themselves. These two limitations pose a huge hindrance to the drug screening process, making it tedious and financially burdening. Chemists Richard Lerner and Sydney Brenner were discussing these very issues when they had the novel idea to bequeath the enviable properties of




DNA to the hapless chemicals by ligating DNA itself to the chemical molecules. Thus, DNA encoded chemical libraries were conceived.

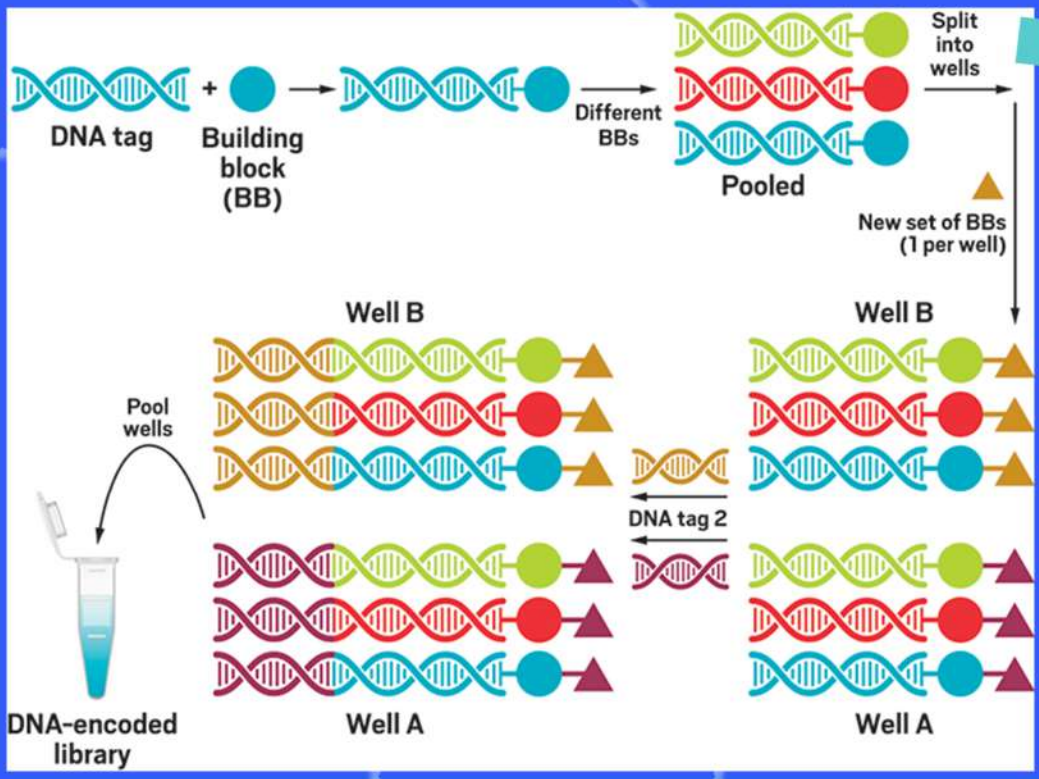
## Construction

Each 'book' in the DEL consists of a chemical molecule attached to a short, unique strand of DNA that serves as a barcode that can identify the molecule and be amplified and contains the instructions for re-synthesising that respective chemical. DELs are built by a split and pool method. Each of these units is assembled by attaching DNA to a small organic building block. Many such assemblies (forming a pool) are split into wells, and then each sample is attached to another building block along with its respective identifying DNA tag. In this way, the process is repeated to build an entire chemical library with the DNA barcodes recording the chemical reactions involved in synthesising the final molecules.

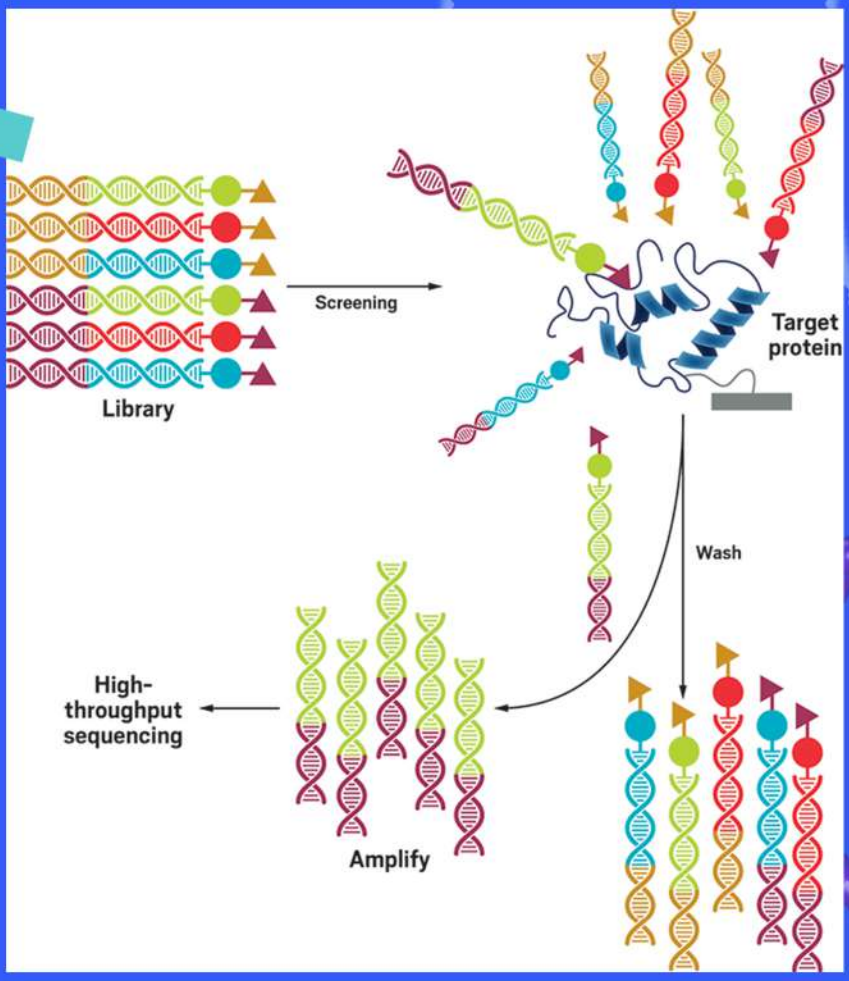
## Screening Process

A library can contain trillions of compounds which can be screened against a single target molecule simultaneously. The mixture of 'books' are first added.

lowed by target molecules like proteins and binding efficiency is subsequently tested. The unbound constituents are washed away, leaving behind the compatible chemical-target protein complexes. This cycle is repeated several times to narrow down the samples. The DNA tag is amplified and sequenced to identify the potentially viable chemical attached to it and its production instructions. That particular compound is then re-synthesised on a large scale without the DNA barcode attached for further testing of biological effect on the target molecule.




Using conventional screening methods like high-throughput screening (HTS) takes much more time, and resources and hence researchers welcome DEL technology with open arms. Let us examine the case where we have to find inhibitors for 50 particular enzymes against 1 million sample chemicals. Procedures like HTS would require conducting 50 million experiments not to mention the building-size instrumentation involved. On the other hand, the DEL pathway requires merely 50 experiments each testing the million samples against the target enzyme one-by-one.




*"It is truly one of the most profound and original ideas in chemistry, and the consequences are only just beginning to be felt."*

-Roger. D Kornberg. biochemist. Stanford University

Trillions of compounds fit inside one Eppendorf tube and can be screened by one person. This low-cost and time-efficient technology is a huge boon to young academicians and small start-ups which can now access a wide range of chemicals for their research. With the immense impact on drug discovery. pharmaceutical endeavours. and biotechnology. there is a bright future for this newfound prodigious tool.

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# A star is born

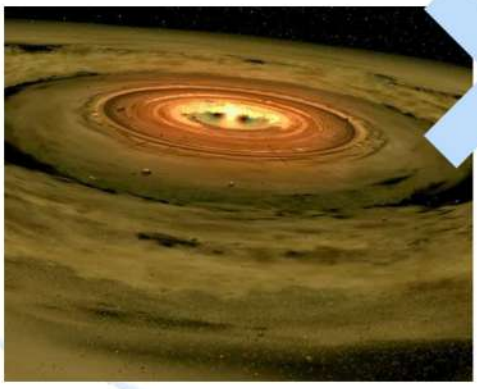
*"I am Vaishnavi CM, an aspirant of biotechnology. I want to get into the field of research and my current interest lies in genetics. I find my solace in music, reading novels and binge-watching shows. I love to do yoga and am interested in arts like hairstyling, nail art. My achievements include attaining scholarships for 3 consecutive years in high school and the CV Raman scholarship in my first year of Bachelors."*

*-Vaishnavi CM(4BCZ)*

Happening in the depths of the vast cosmos.
And in our home, the solar system, also giving life to asteroids and comets.
Starting with the pre-stellar core, in the cold and dense pre-collapse phase, molecules freeze-out forming ice.
With subsequent hydrogenation of atoms and CO on the grain surface, complex organic molecules and hydrogenated species are formed, marking the beginning of star formation.

Next, follows the protostar stage.
The spectrum, characterized by various lines of deuterated species, complex molecules and Sulfur bearing molecules.
Furnishing a complete inventory of neutral and ionic C-, N- and S- bearing species, including the detections of $HOCO^+$ and $HCNH^+$, $HC_3NH^+$, it secures detections of the deuterated ions $DCS^+$ and $DOCO^+$ for the very first time.

And lastly arrives the protoplanetary phase.
Matter accretes onto the central object, the jet disperses and the envelope dissipates and the ices sublimate.
Spectral lines of CO and its isotopologues are detected.
Out?ow shocks compress and heat the interstellar material sputtering the grain ice mantles.
With extremely-high-velocity gas forming "molecular bullets", the circumstellar envelope dissipates, allowing the radiation of the central object to escape at increasing distances.



And this is the astrochemical story of how a star a born.

## Reference

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# A case study report on Lead poisoning due to incense burning

*I'm Sonali, an aspiring Researcher from Mangalore, Karnataka. I like learning from nature and interacting with diverse people. I enjoy singing, dancing, and acting as part of my hobbies and share the same as my areas of achievement in University. This report is on Lead poisoning caused by incense sticks, which we usually use as a room freshener or as part of religious practice. This report intends to indicate the need for alternative eco-friendly practices.*

*-Sonali Umanath(4BCZ)*

Lead is a chemical compound widely used in different sectors and industries like smelting. refining. battery manufacturing. etcetera. It is non-biodegradable and causes health hazards on accumulation. Its

Incense burning is an activity or ritual included in many religious practices worldwide. These incense sticks contain several aromatic compounds. resins. herbs. and synthetic chemicals that release the aromatic fragrance. This fragrance is used to please the deities and perish the devils in the surroundings. The incense stick smoke is one source of indoor air pollution and consists of carcinogens like polycyclic aromatic hydrocarbon and particulate matter. and toxic metals.

We will look into a case of lead poisoning caused by lead in three generations of a family in China in 2016. Given below is the information about a 65-year-old homemaker's family.

| Number | Realtion with the homemaker | Age | BLL (mg/dL) before | BLL(mg/dL) after | Health Issues |
|---|---|---|---|---|---|
| Patient 1 | The homemaker | 65 | 57.2 | 29.6 | Dizziness, general fatigue, severe normocytic anemia, lower leg pitting edema, sore limbs, abdominal pain, and exertional dyspnea |
| Patient 2 | Husband | 67 | 80.2 | 22.4 | Chronic hypertension |
| Patient 3 | Daughter | 35 | 7.8 | NA | NA |
| Patient 4 | Son | 36 | 62.2 | 14.3 | NA |
| Patient 5 | Son's wife | 34 | 31.1 | 12.8 | Breast Cancer |
| Patient 6 | Grandchild 1 | 5 | 43.6 | 6.4 | Hyperactivity |
| Patient 7 | Grandchild 2 | 3 | 38.9 | 8.2 | NA |
| Patient 8 | Grandchild 3 | 12 | 34 | 3.6 | NA |
| Patient 9 | Grandchild 4 | 11 | 49.5 | 8.2 | Hyperactivity |

Table 1 Family Details

The 65-year-old Homemaker faced several health conditions but showed no history of exposure to lead. Her bone marrow biopsy results showed a 60% cellularity and typical topography. Her Hb levels (Table 1) worsened as months passed. despite consuming iron supplements. She had high Blood Lead Levels (BLL) (Table 1) and underwent cycles of chelating. Basophilic stippling in peripheral red blood cells was assumed to be the source of lead poisoning.

She lived with her husband. Son. Son's wife. and four grandchildren. The daughter had moved out 13 years before the field investigation and had a lower BLL than the rest of the family. All the family members were tested for lead exposure and abnormal BLL. Apart from Patient 5 (daughter). all the family members went through 1-3 series of chelating. Her husband (Patient 2) worked for 20 years and received two chelating courses in 3 months. Her Son worked in a trading company and believed that his workplace could have been the lead exposure source. In 2017. his wife was diagnosed with breast cancer and received one chelating cycle. The grandchildren had shown no specific health issue.

| | Pb | As | Cd | Hg | Cr | Cu | Zn | Mn | Ni |
|---|---|---|---|---|---|---|---|---|---|
| Doorstep | 31.72 | 2.891 | 0.437 | 1.681 | 43.10 | 56.97 | 415.4 | 373.7 | 22.76 |
| Ceiling Fans | 37.95 | 2.321 | 0.781 | 6.267 | 55.09 | 268.3 | 634.0 | 224.6 | 56.07 |
| Incense (new) | 0.462 | 0.518 | 0.062 | 5.151 | 10.14 | 2.324 | 6.905 | 66.62 | 5.721 |
| Incense Coils | 16.02 | 0.127 | 0.031 | 2.601 | 7.784 | 5.521 | 91.58 | 65.14 | 4.359 |
| The soil on the road | 31.72 | 2.891 | 0.437 | 1.681 | 43.10 | 56.97 | 415.4 | 373.7 | 22.76 |

Table 2 Composition of dust found in different locations[1]

The Homemaker had served as a Daoist clergy for more than 30 years. She conducted the rituals on the second floor of her house and used nearly six incense sticks for one service. The air composition in the room had to be tested. The room's walls were covered with wallpaper. and after a regular day of service. dust from the wallpaper was collected. Incense samples for heavy metal assay were obtained. Although she shifted to eco-friendly incense sticks. the lead content was reduced overall but still potentially dangerous.

Toxic metals, like manganese, nickel, zinc, and copper from the dust particles, were also obtained. Due to incense sticks' slow and incomplete combustion, it is more likely to cause upper airway irritations, especially in poorly ventilated rooms. Studies identified incense burning at homes as a significant causative factor for increased BLL between 1.70 ± 1.51 and 1.92 ± 1.57 mg/dL ($p < 0.0003$) was associated with delays in the gross motor neurodevelopment. Therefore, if not stopped, the overall usage of incense sticks must be minimized to a large extent to avoid lead accumulation in house dust. To use incense sticks in well-ventilated rooms is also suggested.

## References:

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[2] A. L. Wani, A. Ara, and J. A. Usmani, "Lead toxicity: A review," Interdiscip. Toxicol., vol. 8, no. 2, pp. 55-64, 2015.

# Treatments for SARS-COV2

*Co-Editor*

*-Parithossh R(6BCB)*

Covid-19, being one of the biggest outbreaks in the 21st Century. The outbreak started in the Hubei Province, China at the end of the year 2019. Now in the year 2021, there are around 117 million recorded infections around the world and 2 million deaths. But this Pandemic has led to a lot of research in the field of Virology, pharmaceuticals, Biotechnology, etc. A whole lot of treatments were deduced for the treatment for the patients infected with the virus, and also for the immunity against the virus. We will look at the major different drugs, treatments that were approved for the treatment of Covid-19.

## Drugs

Remdesivir:

Remdesivir is a pro-drug that is an ATP(Adenosine triphosphate) analog. It is a drug administered to patients with viral diseases. The IUPAC name of this drug is 2-ethyl butyl(2S)-2-[[[(2R,3S,4R,5R)-5- (4-aminopyrrolo[2,1-f] [1,2,4]triazin-7-yl)-5-cyano-3,4-dihydroxyoxolan-2-yl]methoxy-phenoxy

phosphoryl]amino]propanoate with a Molecular formula $C_{27}H_{35}N_6O_8P$ [1].

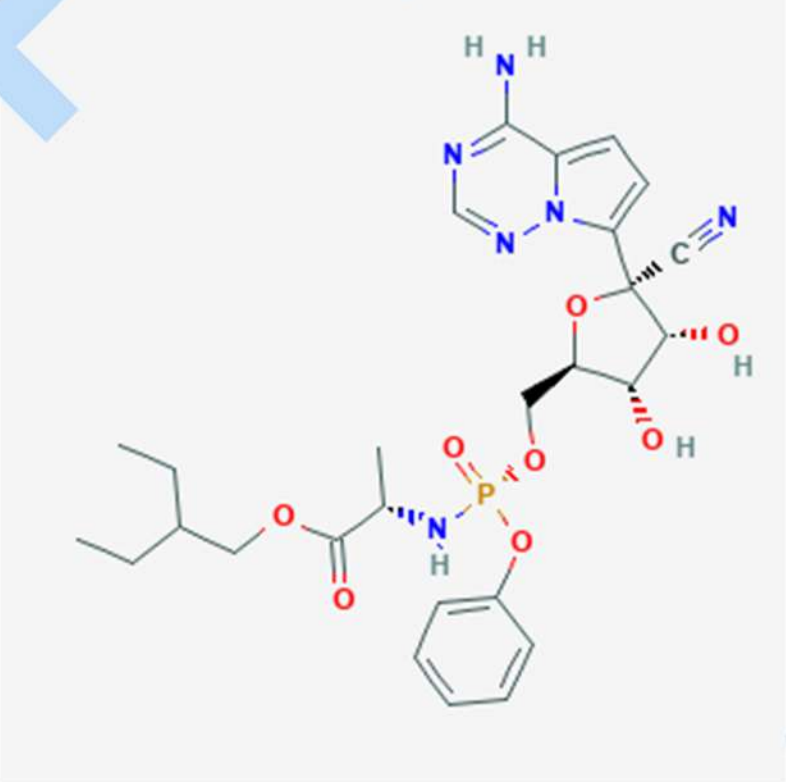

Fig 1 The Structure of Remdesivir
Source(Remdesivir | C27H35N6O8P - PubChem (nih.gov))

Remdesivir acts as an antiviral agent, especially for RNA Viruses. This acts as an inhibitor of the RNA Polymerase(RNA-dependent RNA polymerase). This Inhibitory action of Remdesivir was observed on Novel Coronavirus, Severe Acute Respiratory Syndrome Coronavirus 2(SARS-COV2) in vitro[2]. In an Adaptive Covid-19 Treatment Trial (ACTT-1) conducted on patients infected with the virus. This test was to compare the treatment of Remdisivir with placebo. It was seen that Remdisvir was having a shorter recovery time than placebo[2].

Remdesivir has a less significant effect on RNA polymerases of the human mitochondria, there it has more tolerability. Yet this drug has a risk for hypersensitivity allergic reactions, like anaphylaxis and increased

transaminase levels. Its efficacy also decreases when it is used with Chloroquine and HCQ(Hydroxy Chloroquine).[1]

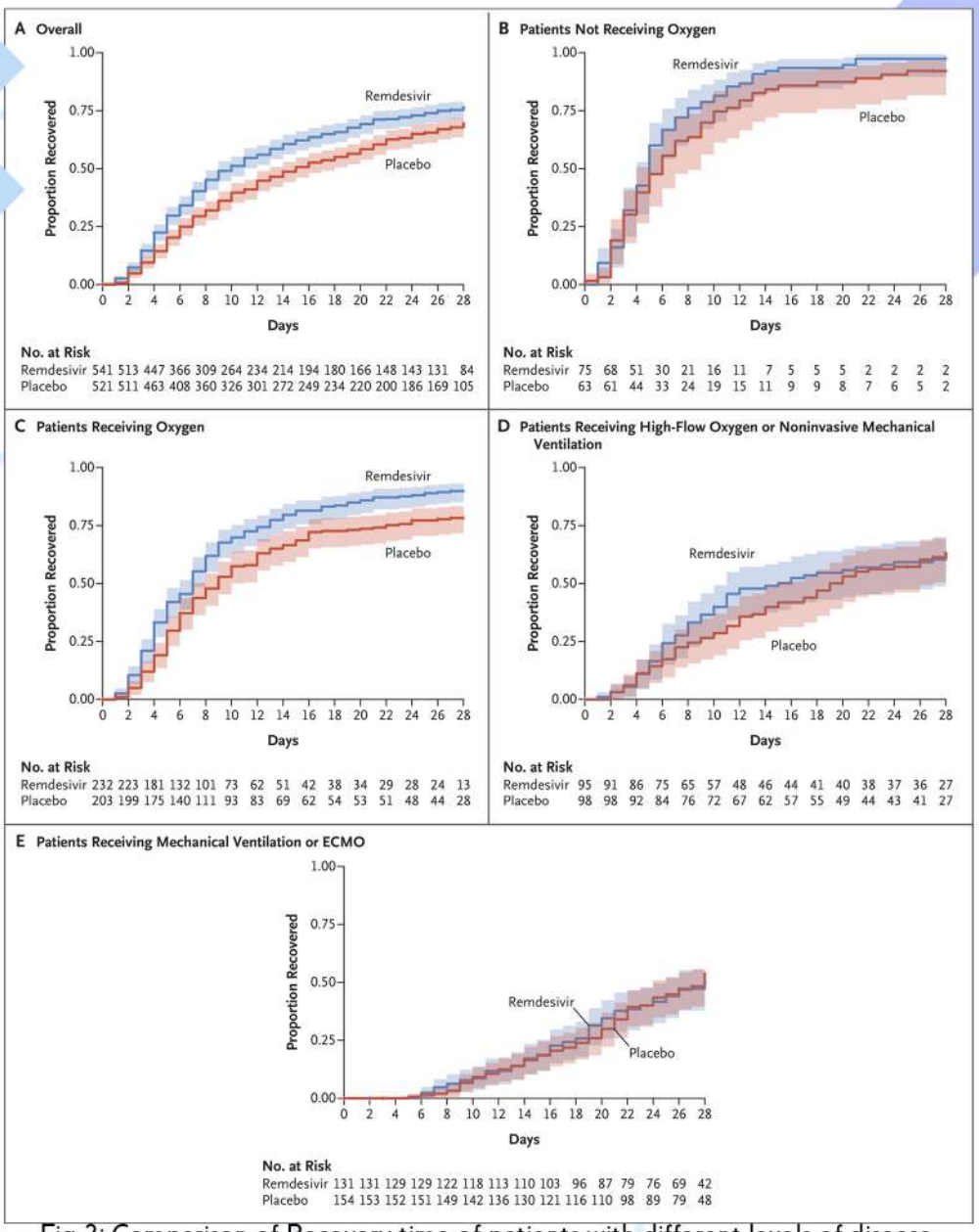


Fig 2: Comparison of Recovery time of patients with different levels of disease, administered with Remdesivir and Placebo.
Source- (10.1056/NEJMoa2007764)

This nucleoside triphosphate has a biological half-life of twenty hours in humans. The drug has to be digested to its active form, i.e., triphosphate. A cycle of hydrolysis in the body gives an alanine metabolite which upon further hydrolysis will produce nucleoside metabolite, or if phosphorylated

by the cellular kinases produces an active form of triphosphate[1].

Dexamethasone:

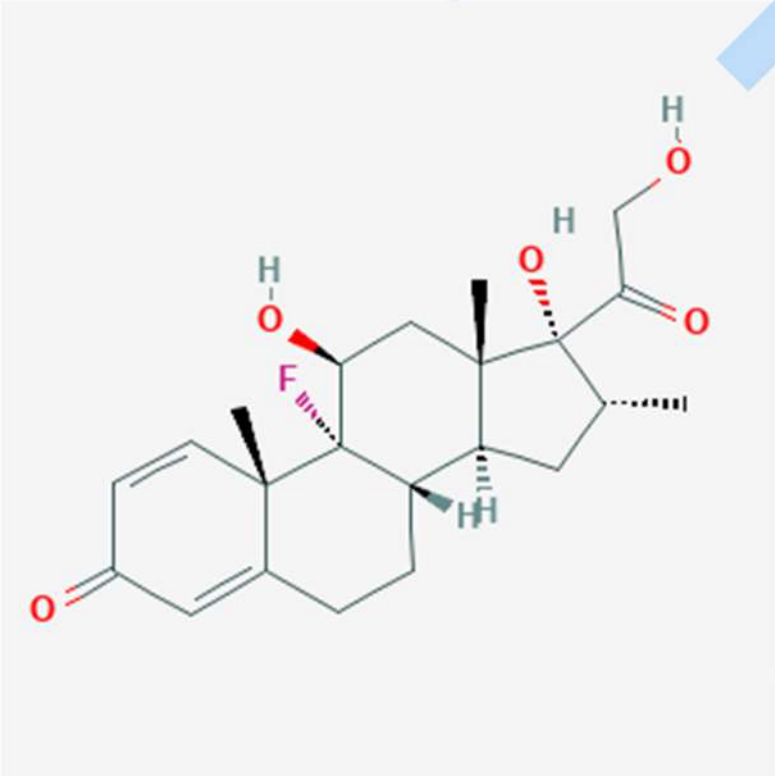


Fig 3: The Structure of Dexamethasone

IUPAC name:
(8S,9R,10S,11S,13S,14S,16R,17R)-9-fluoro-11,17-dihydroxy-17-(2-hydroxyacetyl)-10,13,16-trimethyl-6,7,8,11,12,14,15,16-octahydrocyclopenta[a]phenanthren-3-one[3].

Dexamethasone is a drug used for many conditions, but it` s major role is as an anti-inflammatory. Dexamethasone is a corticosteroid. It also used as Anti-neoplasts. Dexamethasone was approved for the management of Covid-19 after the clinical trials by RECOVERY in the UK. This Corticosteroid goes and binds to the glucocorticoid receptors, therefore leading to the inhibition the anti-inflammatory signals produces by the body. This drug was observed to be most effective on patients which require oxygen

support[3][4]. Covid-19 in some patients can lead to the development of pneumonia. This the major reason for the death related to Covid-19 as it leads to a condition called Acute Respiratory Distress Syndrome(ARDS). The Covid-19 derived pneumonia is caused due to the release of inflammatory cytokines. like TNF-□. which is an inflammatory cytokine that is secreted by the innate immune cells. Neutrophils[4]. Dexamethasone acts a synthetic cortisol and acts upon these Cytokines produced by the immune cells. thereby decreasing the severity of ARDS[4].

## Monoclonal Antibodies

Antibodies are proteins that are a part of the adaptive immunity of an organism. These proteins bind to te antigenic epitopes to induce phagocytosis. Monoclonal antibodies are prepared in vitro using hybridomas. The monoclonal antibodies have monovalent affinity. Currently companies like Eli lilly have developed monoclonal antibodies. named bamlanivimab (LY-CoV555).

This antibody will bind to the epitome of the S Spike protein of the SARS-COV2 and neutralize it.

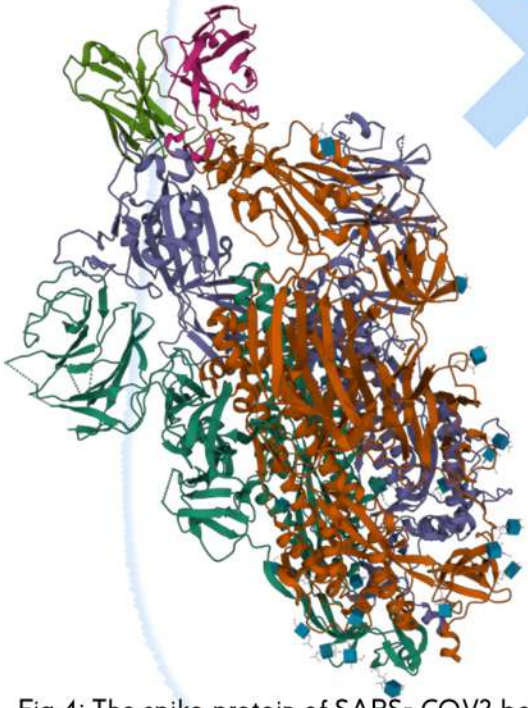

Fig 4: The spike protein of SARS- COV2 being neutralized by CoV555
Source- (RCSB PDB - 7L3N: SARS-CoV 2 Spike Protein bound to LY-CoV555)

## Vaccine

As of march 2020. genomic sequence of SARS-COV2 was released which was creating the infection. From then on there were countless efforts on creating a vaccine against the virus around the globe. Various technologies were available for the development of the vaccine(Attenuated virus. protein. viral vector. Nucleic acid. etc.).

Moderna was one of the first companies to start developing a vaccine. They were developing an mRNA vaccine. Adjuvanants could be used to enhance the immunogenecity. for example MF59. Most candidates used the S Spike protein of SARS-COV2 to produce the vaccine[5].

Pfizer Vaccine for SARS-COV2 ingredients-

The active ingredient for the vaccine. which will induce the immunogenic reaction is modRNA for the viral spike glycoprotein (S) of SARS-CoV2. And lipids which are as liposomes to deliver drugs like. 4-hydroxybutyl)azanediyl)bis(hexane-6.1-diyl)bis (ALC-3015): (2-hexyldecanoate).2-[(polyethyleeglycol)-2000]-N.N-ditetradecylaceta mide (ALC-0159: 1.2-distearoyl-snglycero-3-phosphocholine (DPSC): cholesterol[6]. And salts like potassium chloride. monobasic potassium phosphate. sodium chloride basic. sodium phosphate dihydrate as buffers.etc. and nutrient source as sucrose[6].

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# Water is no Longer $H_2O$!

-PRASIDDHA NAGARAJAN(2MCHE)

The earth's crust consists of 71% water, out of which only 1% is freshwater. With the continuous depletion of freshwater resources owing to pollution and urbanisation, a solution to the problem seems impossible and unreachable. And Indian water resources, once famous for their beauty and rich biodiversity, have now become an example in textbooks for water pollution. The very fact that the disgust and sorrow that brews while looking at these water bodies is not manifesting into an urge to create a difference is in itself the biggest threat to their downfall. As articles in newspapers show the deaths associated with the consumption of contaminated water, movies, and the media, striving to create awareness, and many more activities continue to happen.

Considering the bigger picture. what have we gained? Nothing. The past two decades. which have faced industrialization at its Considering the bigger picture. what have we gained? Nothing. The past two decades. which have faced industrialization at its strongest. have led to this irreversible damage of the most important biosphere - the water resource. Being from Chennai. I would like to focus on the water bodies here. This. however. does not imply that other cities or states are doing their work responsibly. I call this the trailer to the bigger picture.

Between 1980 and 2010. heavy construction in the city meant that buildings' area increased from 47 to 402 square kilometres while wetland areas declined from 186 to 71.5 square kilometres. This led to the disruption of the continuous waterways and a constant hindrance to their path of flow. Half the buildings today stand on rivers that have been converted into wastelands for construction works. I would like to focus on two main water bodies that run through Chennai city's heart but are damaged beyond repair. That said. Chennai is one of the most beautiful places. and the accounts described below exist in all cities in India. Consider this an eye-opener and kindly spread the message.

## The Buckingham Canal

The Buckingham Canal is a man-made canal that is 460 km long. with 257 km running through Andhra Pradesh and 163 km running through Tamil Nadu. Approximately 31 km runs within the city limits of Chennai. This canal. which was built in 1806. has an undeniable potential. which has continuously placed it as a key feature in many urban development projects since the beginning of this century. Sounds beautiful. doesn't it? Now. let us look at how time has tested the canal.

During world war II. the boat traffic in the canal is said to have been at its peak! Even a paper boat cannot be imagined in today's scenario. Even though the canal is highly polluted and unfit for any domestic use. it still acts as a buffer in case of natural calamities like floods or Tsunami. During the 2004

tsunami. one of the worst hits in history. Chennai faced a quick recovery and quickly receding water because of the intake capacity of the canal. where the water quickly receded into the sea.

Continuously fed with industrial effluents. sewage wastes. and silting up of the canal. the water has become stagnant and an attractive lodge for mosquitoes to breed and enjoy. The North Chennai Thermal Power Station (NCTPS) discharges hot water and fly ash into the canal. and this rise in temperature and particulate matter is the poison that has killed aquatic life for years. The water quality is considered highly toxic and completely non-potable.



WHO classifies metals according to their toxicity and has determined the permissible levels of these metals in potable water. These permissible limits and their accumulation beyond limits are mentioned here:

| S.No | Metal | WHO limit (mg/L) | Measured value (mg/L) | Sources | Impact |
|---|---|---|---|---|---|
| 1. | Chromium | 0.1 | 0.006-0.012 | Electroplating and tanning industries, dyeing, landfill leaching, corrosion inhibitors used in water pipes. | Pulmonary sensitization, dermatitis. Chronic exposure may cause lung, nasal, and sinus cancer. |
| 2. | Copper | 0.05 | 1.04-1.34 | Anthropogenic activities like antifouling marine paints, wood preservatives, and regular industrial effluents. | Cellular damage-causing production of free radicals, brain damage to mammals, and inactivation of biological thiols to disulfides. |
| 3. | Iron | 0.3 | 0.23-1.75 | Vehicular discharge, oil, and fuel leakage into the soil, which deposits in the banks of the water bodies. | Rapid absorption in the gastrointestinal tract causes bioaccumulation and even death. |
| 4. | lead | 0.043-0.055 | 0.05 | Leakage from batteries and industrial equipment, chalking and flaking of paints in the banks, dissolution of vehicular pollutants. | Lead poisoning causes stunted growth, Diminished nervous response, and impotence |
| 5. | Zinc | 5.0 | 1.6 | Discharges of smelter slags and wastes. Fly ash, wood preservatives, and fertilizers. | Bioaccumulation in aquatic organisms, which is consumed by other mammals and humans, causes toxic effects in the offspring. |

## Cooum

The Cooum river is 65 KM long. originates at kadambathur in the Thiruvalluvar district in Tamil Nadu. enters the city of Chennai ner Aminjikarai and finally empties it` s waters into the Bay of Bengal at the marina beach. It was an exotic biodiversity hotspot before the entire process of spoilage began.

## HOPE FOR A BETTER TOMORROW

Prevention of further damage of these water bodies, desilting processes, water-treatments, conservation of banks of rivers by the declaration of these zones as vulnerable areas, and many more are simple solutions that could be issued by the government and followed by people without much strain and expense. But on a larger scale, to witness and bring back the full beauty and purity of these water bodies will require immense effort and expenditure. Hoping that the government and people will wake up soon, imbibing the lessons the COVID pandemic has taught us, and progress towards an eco-friendly and responsible future.

Water is the elixir of life. Let us not turn it into poison.

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# Utilizing Immune system to combat cancer!

*"I am Akshata. Interest in molecular biology and genetics is what made me choose my course. I have an interest in oncology. And I love poetry too. So here is my attempt to explain the recent chemistry research in cancer biology, in a poetic manner."*

*-Deshmukh Akshata(4BCB)*

Cancer-a deadly disease:
Continuous division of cells, no apoptosis.
Inhibition of contact and metastasis.

Many doors for a solution over this malady being knocked.
For preventing more such patients from getting knocked.

Radiotherapy- targeted cell therapy.
Surgery and chemotherapy.
Being some of the gates of hopes.
That researchers keep on searching for. with some hope.

Yes. they did open these solution gates.
But it doesn't work for all. so just wait.

Why not use Immune system against it?
It will be PEACE if T cells recognize it.
Why don't the T cells act against it?
What is it that prevents immune action against it?

Answer arrived after a long scuffle.
Between the great brains and these questions.
It is the PD-L1 and PD1 interaction over the cancer cell` s surface.
That protects them from any action being faced.

Thus. now. researchers planned to synthesize such molecules.
That will make PD-L1 lose its purpose as such a molecule.

Monoclonal antibodies against PD-L1 was one option.
But. it had many drawbacks. like:
Long half time and poor oral availability.
Forcing researchers to find something else. leaving no option.

Thus they synthesized some molecules.
Leaving behind the drawbacks of Monoclonal antibody molecules.

These were a group of drugs.
Called PROTACs (Proteolysis Targeting Chimeras).
Which were nothing but.
resorcinol diphenyl ether-based.

1 linkage and 2 functional parts.
PROTACs, a whole, are made by these parts.
One binds to the protein degrading protein.
Other to the target protein.
It is the 1st time that there exists something.
That does both-inhibition and degradation of PD-L1 proteins.
This now initiates a significant breakthrough in therapy.
That will make the immune system act against cancerous cells.

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# The Evil Seduction of Ayurveda

*Co-Editor*

*-Ankush (6CBZ)*

The invention of the number system, the exquisite architecture, and the sheer diversity in the rituals and practices make India one of the largest primary contributors to civilization as we know it, comparable only to Ancient Greece, China, and Egypt. However, India finds itself in a unique position. Out of all the countries mentioned above, it is the only one that has failed to move on from its past glories. It is blinded by its shining history - filled with beauty, knowledge, and, most important of all, logic. So much so that it has abandoned the very values its history maintained. One out of the large group of seductive elements in Indian culture is particularly notorious: Ayurveda.

Some sources say that approximately 80% of Indians use Ayurveda, either

exclusively or in combination with conventional western medicine [1]. However, multiple scientific studies have shown that Ayurveda alone is incapable of curing any disease [2]. Some concoctions are particularly dangerous as they seem to contain heavy metals like mercury and lead, which are poisonous [3]. An atrocious example is of a drug - supposedly to help digestion in infants - "ghasard." This drug, according to a 2008 study done by Karri et al., can have up to 1.6% lead concentration (by weight) and "lead" to a condition known as "toxic encephalopathy," which can permanently damage the brain [4]. This is just one example of numerous others that Indians consider an effective, safe alternative to western medicine when in reality is either an intentional lie or an unfortunate mistake.

As a practice, Ayurveda is regarded as a pseudo-scientific system due to the incorporation of metaphysical and supernatural elements into itself. It lacks scientific evidence, and in most cases, there's evidence against it. Nonetheless, some plants and plant products indeed contain beneficial properties - like Turmeric - but most do not. With that said, there could be some other benefits of Ayurveda, as is demonstrated by the innumerous testaments to its efficacy, which might simply be due to the nutrition-rich concoctions, perhaps coupled with the famed placebo effect.

In contrast, Allopathy has a disproportionately poor reputation amongst the people of India. A likely cause is the glorification of Indian medicine in combination with the distaste of synthetic and non-organic produce.

In this ironic age of information and misinformation, it is indeed hard to discern facts from opinions. Science and the scientific method, however, provide a reliable source of information. Science exercises the power of logic and reason to give results. And when these results are confirmed with other independent experiments, it further increases the likelihood of their correctness. Along with the powerful employment of logic and systematic experimentation, modern Science requires from its contributors a certification - provided by a strenuous peer-review process - that judges the research to be of high quality.

Ultimately, it is clear that Science, in principle, is free of any bias, thus, making it the only possible gauge of the objectivity of a claim. It might be the case that some baseless claims are true, but it is our responsibility - for our own safety - to deny a platform to claims without any evidence, popular or not. This must include all alternative medicines: Homeopathy, Naturopathy, Chinese medicine, and the practice that is declared scientific in India - Ayurveda.

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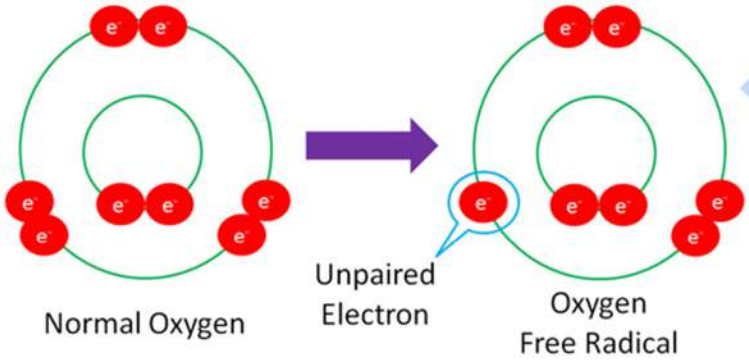
# Chemistry of free radicals and their effects on human biology

*"My name is Anupriya Garg and I am a First-year Undergraduate student of Biotechnology in Christ University. I have an enthusiasm for Science and Technology and am a hardcore believer in its potential. This article covers what free radicals are in simple terms and what does it do the human body. I was really impressed by what and how free radicals as a chemical species can do to our body, interacting even with our DNA! The article also makes one realize the science behind doctors recommending antioxidant-rich diets."*

*-Anupriya Garg(2BCB)*

Research on free radicals has gained importance in the field of biology due to their central role in various physiological conditions as well as in the implication of wide range of diseases. In higher concentrations. they can lead to increased oxidative stress and can thereby negatively affect various important classes of biological molecules and can even lead to wide range of diseases. This article deals with chemistry. formation. sources and effects of free radicals providing a brief overview on how it damages the body and what are the counter attacks there are in place to tackle them.

Radicals are the species which contain at least one unpaired electron in the shells around the atomic nucleus and are capable of independent existence.




**Normal oxygen is converted to an oxygen free radical by losing one electron in its outer orbital, leaving one unpaired electron**

**Fig. 1**

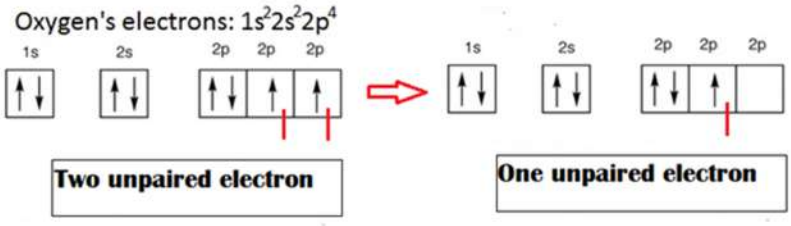



**Fig. 2**

Fig. 1. photo via
https://courses.lumenlearning.com/suny-nutrition/chapter/9-11-free-radical

With few exceptions, free radicals are found to be highly reactive species. You would want to consider that these species could be positive, negative or neutral. In fact, an oxygen atom is also a free radical. Because of the presence of two unpaired electrons, it is referred to as biradical. It is a neutral species.

But what about the molecule at the right in Fig.1. Yes of course it still has one unpaired electron but has a positive charge overall. So, it is a positive free radical.

What about Na and $Na^{\bullet}$ ?
Na is also a free radical and a neutral species but $Na^+$ is not a free radical as it has all paired electrons. It does have a positive charge. Thus, we call such species as cation.

But how do we end up having free radicals in our body and what they actually do?

Free radicals are formed in our body as a product of cellular metabolism. They could be reactive oxygen species or reactive nitrogen species.

Table 1

| Reactive Oxygen Species | | Reactive Nitrogen Species | |
|---|---|---|---|
| Superoxide | $O_2^-$ | Nitric oxide | $NO^-$ |
| Hydroxyl | HO | Nitrogen dioxide | $NO_2$ |
| Peroxyl | ROO | Nitrous acid | $HNO_2$ |
| Perhydroxyl radicals | $HO_2$ | Peroxynitrite | $ONOO^-$ |
| Alkoxy | RO | Alkyl peroxynitrite | ROONO |
| Hydrogen peroxide | $H_2O_2$ | | |
| Singlet oxygen | $^1O_2$ | | |

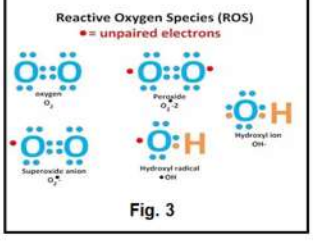



Fig. 3

Fig. 3. photo via
https://www.quora.com/What-are-the-dangers-of-reactive-oxygn-species-in-the-body

They form when one of the weak bonds between electrons is broken and an uneven number of electrons remain. Since electron is now unpaired. they are unstable. short-lived and chemically reactive. Due to their high reactivity. they can remove electrons from other compounds to attain stability. As a result. the attacked molecule loses its electron and becomes a free radical itself. beginning a chain reaction that can finally damage the living cell. It is reckoned that the chain reaction can trigger 6.023 x 1021 billion molecules to react per second! So you see this is like a zombie apocalypse. If Free radicals simply killed a cell. it would have been okay because the body could just make another one. The problem is that when the free radical damages or changes. say. the cell` s DNA. this is the seed of cancer. aging and many other diseases.

Endogenous sources of free radicals include mitochondria. peroxisomes. endoplasmic reticulum. phagocytic cells etc. whereas exogenous sources include alcohol. tobacco smoke. pollution. transition metals. industrial solvents. pesticides. certain drugs like halothane. paracetamol. and radiation. To your surprise. sometimes free radicals that can harm your body are also the ones that are needed in the immune system to fight against pathogens. Yes! The free radicals play a dual job as both beneficial and toxic compounds to the living system. At moderate or low levels. they have beneficial effects and are involved in various physiological functions such as in immune function. in a number of cellular signalling pathways. in mitogenic response and in redox regulation.

So. what we see here is that the body can normally handle free radicals with its free radical defence system i.e.. when they are kept under control by molecules called antioxidants. which the body produces naturally and gets from food.

(Free radicals can be called oxidants/oxidizing agents as they oxidize or remove electrons from other reactants during a reaction. Antioxidants are those compounds that inhibit the oxidation of other molecules. So Antioxidants are molecules that fight free radicals in your body. They donate an electron to free radicals, thereby reducing their reactivity. What makes antioxidants unique is that they can donate an electron without becoming reactive free radicals themselves.)

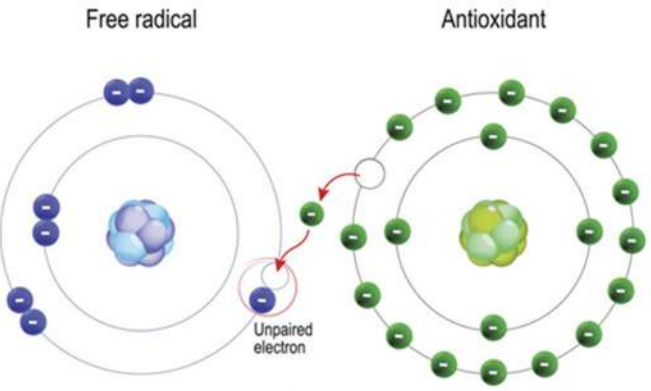



Fig. 4

Fig. 4. photo via https://www.medicalnewstoday.com/articles/318652#How-do-free-radicals-damage-the-body

But what if there is an excess of free radicals on one side and a deficiency of antioxidants on the other side. This kind of situation results in what we call as oxidative and nitrosative stress depending upon which reactive species is in excess. Oxidative stress can damage the body`s cells, which can lead to a range of diseases and also causes symptoms of aging, such as wrinkles.
If I talk about the Oxidative damage that the free radicals do to our DNA, mitochondrial DNA is more vulnerable to the damage than the nuclear DNA due to the close proximity to the ROS generated place.

You remember mitochondria is the site of Oxidative metabolism and so is the place where ROS generates. They are mainly produced by the mitochondrial respiratory chain as a result of electron transport and the reduction of the oxygen molecule. What all these free radical, most importantly $OH^{\bullet}$ radical does is that it directly reacts with components of DNA i.e., the bases, deoxyribose sugar backbone and causes a number of alterations including single and double stranded breaks in DNA. So, DNA gets damaged by the base modifications, deletions, strand breakage, chromosomal rearrangements or hyper- and hypo methylation of DNA. Damage caused by all these cleavage and formation of products may even lead to mutagenesis, carcinogenesis and ageing.

So, damage to the macromolecules can lead to tissue damage and causes diseases such as diabetes mellitus, neurodegenerative diseases, cancer, cardiovascular diseases, cataracts, rheumatoid arthritis, asthma etc.

In Fact, accumulation of oxidative damage has been proposed as one of the many causes of ageing. Described in the 1950s, it has been one of the most popular theories of aging for many years. Abundant data has been produced from various scientific studies on different model organisms supporting the theory or, on the contrary, suggesting strong evidence against it.

Lifestyle factors such as alcohol and fried foods consumption, smoking, exposure to air pollution and harmful chemicals, such as pesticides accelerate the production of these free radicals. Such lifestyle factors have been linked to diseases such as cancer, cardiovascular disease. No single antioxidant can be used in fighting the effects of every free radical.

However, in certain cases, some antioxidants may become pro-oxidants, grabbing electrons from other molecules and creating chemical instability that can cause oxidative stress.

## Antioxidant foods and supplements:

There are thousands of chemicals that can act as antioxidants. These include Vitamins C, and E, glutathione, beta-carotene, and plant estrogens called phytoestrogens. Many foods such as berries, citrus fruits are rich in vitamin C, while carrots are known for their high beta-carotene content. The soy found in soybeans is high in phytoestrogens. This is the reason why health experts now advise to have antioxidant-rich diets.

What researchers can say is people interested in fighting free radical-related aging and diseases should avoid common sources of free radicals, such as pollution and fried food. They should also eat a healthy and balanced diet without worrying about supplementing with antioxidants.

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# High efficient solar panels using principles of biomimicry: A sustainable innovation

*"I'm Sunaina Rodrigues, a final year student pursuing biotechnology. I've always wanted to explore and understand how sustainable energy works. Attending various seminars and doing online courses I've gotten to understand that future will soon depend on it. This article mainly highlights how solar energy can revolutionize our tomorrow."*

*-Sunaina Rodrigues(6BCB)*

## Introduction

Solar panels were a major breakthrough in the field of sustainability. High cost. weather dependency. space occupation and addition of pollution factors during its manufacture transport and installation are major drawbacks. If these major problems could be overcome. then solar panels can be the nation`s future. We have tried to apply our pre-existing knowledge of biomimicry to design a solar panel which would ultimately increase the efficiency of solar panels to a large extent. And reinforce the idea of the renewable resource. sunlight.

This proposed model of the solar panel is destined to have low cost installation and size adaptability so that it can be installed on rooftops and small backyards and not just large open areas which will ensure maximum usage of solar resources for sustenance. The first major problem faced by solar panel installation is its high cost: this problem can be dealt with by a method known as the nano-solar technology using CIGS (Copper. indium. gallium. and selenium). Solar panels manufactured in the form of thin printable films rather than typical fabricated ones. as used today. CIGS are printed on cost efficient aluminium sheets with the help of nanoparticle ink by a technology not very different from the average printing press. . A copper indium gallium selenium solar cell is a thin-film solar cell used to convert sunlight into electric power. It is manufactured by depositing a thin layer of copper. indium. gallium and selenium on glass or plastic backing. along with electrodes on the front and back to collect current. This not only cuts down the cost but also overcomes the problem associated with space. The next major problem is weather dependency: this problem has been prevailing for years and is still a problem. While high intensity of sunlight can be harnessed during the summers. during the monsoons solar panels absorb diffused light and hence solar power production will be reduced. this diffused light. although less intense than direct sunlight helps the photovoltaic cell to produce electricity. In order to increase the productivity during the monsoons. principles of biomimicry can be used on the solar panels.

## LOTUS EFFECT

The epidermal layer of the lotus leaf is known for water repellency (Fig 1).water droplets that fall on the leaf roll off due to its waxy coating. grooves and ridges. Mimicking this phenomenon of lotus effect on the panels would not only help overcome the problem caused due to rain i.e. hindrance of efficiency due to water accumulation on the panel but also helps in enhancing dirt repellence. A cuticle is made up of soluble lipids embedded in a polyester matrix and epicuticular wax crystals jetting out to form a roughened micro-scale surface. that tends to reduce adhesive force on water droplets. as trapped in the interstitial spaces of the roughened surface results in reduced liquid-solid surface area. This allows self-attraction of polar molecules of water to express fully. causing it to form spheres. with a high degree of water repellency. The contact angle of the droplet with the surface is 170° (that of the lotus epidermal layer) making it super-hydrophobic.

Fig-1 : Water repellency of the lotus leaf

## THE INTRICACIES OF CHEMISTRY BEHIND THIS PROPOSAL:

## HYDROPHOBIC SPRAYS

It has a surface coating of aliphatic hydrocarbons. It is inexpensive! A lacquer spray acts as a binder and a surface polish enhances hydrophobicity. the

principle inspired by the` lotus effect` when sprayed on the glass covering the panel. it causes the water droplet to roll off along with dirt particles. The waxy coating is stabilized by hydrogen bonding among hydroxyl groups allowing a greater melting point (90- 95 ° C). all in all. durability.

## HYDROPHILICITY:

Titania (220nm). applied by spin coating method can optimize the maximum reflection of visible light. Its high refractive index is ideal for increasing efficiency. Self-cleaning effect of a photocatalysis based on a 0.2 to 0.5 micron thin film of TiO2. applied on soda-lime glass substrates. They are more efficient in high temperatures and are not affected by rain or acid rain. This model overcomes all the major problems faced by the presently existing solar panels. hence this high efficient solar panel would help in providing a sustainable future.

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# Aroma compounds in Flowers

*"I am Aiswarya P S, second year graduation student of BSc PCM . I completed my schooling in Kerala and pursued these subjects for graduation due to my passion for pure science subjects. The article submitted refers to some of the chemicals that contribute to the aroma of major flower categories. This write-up is a result of the thought that there is chemistry in everything we see around. This also helps us to know about the importance of chemistry in molding our nature to a better place to live in."*

*-Aiswarya P S (4PCM)*

Flowers are one of the most beautiful things we could find around us, and it is the liking factor in nature for most of us. The aroma has a vital role in attracting us towards the flowers other than their colour and appearance. Have you ever thought about the chemistry behind the smell of these flowers? This article is for those who would reply "no" to the former question. Here we would be talking about the chemical compounds behind the aroma of some common flower categories. The smell of any flower is not due to a single chemical compound. But in many cases, there will be a molecule which constitutes more of the compound.

Roses are the most common among flower categories. The smell of roses is

mainly influenced by the compound named (-)-cis-rose oxide. This is an isomer of rose oxide. Another compound that contributes to rose scent is beta-damascenone. Beta- ionone is also an important contributor. Other constituents contributing to the aroma are geraniol, nerol, (-)-citronellol, farnesol, linalool.

Carnations are used as a common component in bouquets. The major components of the odour of carnations are eugenol, beta-caryophyllene, and benzoic acid derivatives. Eugenol and methyl salicylate in the aroma volatiles. Eugenol is found in cloves, and methyl salicylate is commonly known as wintergreen.

Violets are having ionone as a major aroma component. Ionone has a peculiar interaction with our olfactory receptors. As a result of this, interaction the scent of violet appears to disappear then reappear.

Lilies are commonly associated with funerals. Their aroma composition contains ε-beta-ocimene and linalool. Other compounds contributing to the aroma in Lillies include myrcene and 1,8-cineole(eucalyptol).

Hyacinth contains three main aroma compounds which contribute to its scent. They are Ocimenol, cinnamyl alcohol and ethyl-2-methoxy benzoate. Cinnamyl alcohol is found in cinnamon.

Chrysanthemums contain terpene compounds such as alpha-pinene, eucalyptol, camphor, and borneol as compounds for scent. Besides they also contain chrysanthenone, chrysanthenyl acetate and beta-caryophyllene as contributors.

The major component in the fragrance of Lilacs is ϵ-beta-ocimene. Benzyl methyl ether also has a role in the aroma of these flowers, contributing a fruity odour.

Other than the flower categories mentioned above, there are many other

types of flowers, and they contain their chemicals for specific fragrance. However, the ones discussed above are the most common flowers we see around us. It is fascinating to know about the chemistry behind the aroma they spread.

# Quizlet

.1. This scientist and historian is better known for his discoveries of elements. In 1807, he discovered 2 elements- Sodium(Na) and Potassium(K) within days of one another. Who is this scientist?

2. A very popular Russian story is that it was Dmitri Mendeleev who came up with the 40% standard strength of X in 1894, after having been appointed Director of the Bureau of Weights and Measures with the assignment to formulate new state standards for the production of X. This story has, for instance, been used in marketing claims by the Russian Standard X brand that, "In 1894, Dmitri Mendeleev, the greatest scientist in all Russia, received the decree to set the Imperial quality standard for Russian X and the 'Russian Standard' was born", or that the X is "compliant with the highest quality of Russian X approved by the royal government commission headed by Dmitri Mendeleev in 1894." What is X?

3. The Curie family has won 5 Nobel prizes, making them one of the most decorated scientist families in world. They` ve won 2 Nobel Prizes in Physics, 2 in Chemistry, and 1 in Peace as a part of an international organization. Which organization?

4. The Brazil nut (Bertholletia excelsa) is a South American tree native to Guianas, Brazil, Venezuela, eastern Colombia, eastern Peru, and eastern Bolivia. The fruit of the Brazil Nut is radioactive because of the presence of two elements - Radium and X. Identify X.

5. The odour of this fruit is due to ethyl formate, which has also been found to exist in the middle of the Milky Way galaxy. Which fruit?

6. In an experiment, dissolved carbon dioxide was lost as fizz from both

Coca-Cola. and sparkling water. It was found that the pH of sparkling water increased by a significant amount while the pH increase in Coca-Cola was significantly less. Which other compound is added to Coca-Cola for a low increase in pH?

7. X. also known as N-arachidonoylethanolamine or AEA. is a fatty acid neurotransmitter derived from the non-oxidative metabolism of eicosatetraenoic acid (arachidonic acid) an essential ω-6 polyunsaturated fatty acid. The name is taken from the Sanskrit word for "joy. bliss. delight". and amide. The amount of X in cacao is 0.5 μg per gram. This contributes to the mouth-feel of chocolate and why it sometimes gives a ' high ' . What is X?

8. The first full-scale deployment of deadly chemical warfare agents during World War I was at the Second Battle of Ypres. on April 22. 1915. when the Germans attacked French. Canadian and Algerian troops with the gas X. Identify X.

9. Beginning in the 1940s. people in the city X began to notice a persistent brown haze in the air on hot days that caused watery eyes and respiratory problems. They began referring to the haze as smog. but it had a different composition than industrial smog and formed in a different way. It is officially known as photochemical smog. but even though it affects many cities worldwide. people sometimes call it X smog. Where is X?

10. X. in the form of its oxide. was a highly favored poison. being odourless. easily incorporated into food and drink. and virtually untraceable in the body. In France. it came to be known as poudre de succession ("inheritance powder"). What is X?

## ANSWERS

1. Sir Humphry Davy
2. Vodka
3. UNICEF
4. Potassium
5. Raspberry
6. Phosphoric Acid
7. Anandamide
8. Chlorine gas
9. Los Angeles
10. Arsenic