CHRIST
(DEEMED TO BE UNIVERSITY)
BANGALORE · INDIA

Chemmunique

Edition 11

2022

Department of Chemistry

Chemmunique

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Edition 11

Dean's Message

-Dr George Thomas
Dean of Sciences

Chemmunique 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 11th year. It continues to bring good articles, poems and new information contributed by the students of chemistry.

Chemmunique 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 efforts in bringing this issue of Chemmunique through their keen interest and efforts. 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 11th Edition of Chemmunique. It is indeed a great achievement by the department and its students to persistently bring eye-opening ideas about chemistry and is implication to sciences and human life in the form of articles, essays and poems which reach 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 the 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 Nidhin M
Assistant professor
Department of Chemistry

Student Editor

Ritika Menon 2 BCB

Hello!! I am Ritika, a first year student who is pursuing Bsc Biotechnology, Chemistry and Botany. I chose this subject because I have a passion to learn about science and how it helps us view the problems around us and integrate different disciplines of science to help us develop innovative solutions. Other than my academics, I am involved in Classical dance, Reading, Debating and Quizzing.

Madhushree R 4 MAC

I am a second year Master's student, and a former Bsc alumnus, here at CHRIST. I have been associated with the on-going research on materials science/nanomaterials from the department of chemistry for the past 4 years. I always look for wonders that "CHEMICALS" brings on. I believe in the Rohit Paul quote, "Life is chemistry, Dilute the sorrow, Evaporate your worries, Filter your mistakes and boil your ego, You will get the "CRYSTAL OF HAPPINESS". Chemistry is magic and Yeah !!!! unpredictable. My other side-lines are Gardening, Cooking, making crafts and I love EXPLORING new things.

Co Editor:

Muthamma PT 4 MAC

I am Muthamma PT from Coorg, currently pursuing Masters in Chemistry. Hailing from the land known for its greenery, I have always enjoyed learning from nature. Corrosion science has been my field of research for the past 4 years. I truly believe in ecologically beneficial research that promotes green living and conservation of energy, which is of great importance in today's day and age. I am an aspiring chemist and would like to work hard to give my best in what I do. I enjoy gardening, painting and knitting are part of my hobbies. Being passionate about artworks, I've tried to communicate the chemistry behind the poisonous plant called Atropa belladonna through art in this newsletter.

Foreword

We have a great experience being a part of the editorial team for the 11th Edition of the Chemmunique. 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.

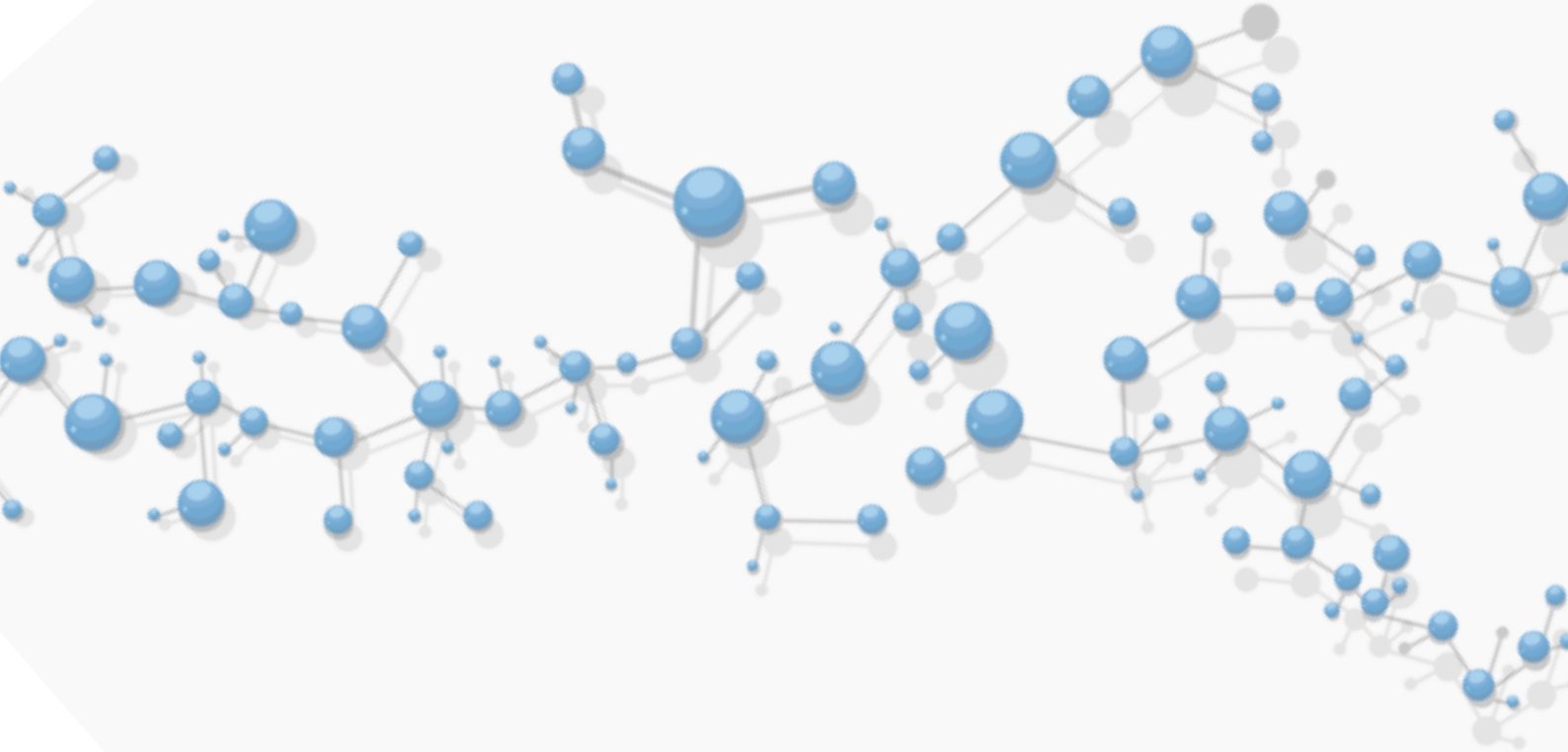
It is however important to know that the very purpose of Chemmunique over the past decade has always been to communicate chemistry and inculcate its interest to the society. It is crucial to ensure that this awareness and interest is independent of one's field of study. The very beauty of Chemmunique has been its interdisciplinary nature of articles. Embracing erspectives and ideas of chemistry along with other physical and natural science, arts and humanities.

This year is no different and we are pleased to present write ups in the form of essays, articles, paintings, poetries and critical commentaries from disciplines that are on the orter end of the spectrum but show fascinating relation in chemistry in both practical and theoretical ways.

Finally, since Chemmunique is primarly 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 experiences in our very own department. We also believe that the recently introduced author profiles at the beginning of all the articles allow the readers to further appreciative this perspective and connect with the writer as they read.

-Editorial Team

The Mystery of Chemistry



"Wishing a pleasant day to the fellow readers, this is Mridula. R from 2CBZ. The love towards the subject as well as penning my thoughts and imaginations brought out this poem to you all. I try to exhibit my creativity not only through poems but also by doing art and craft which ends up in decorating my place, bestowing a pleasant environment. Adding on to this I take some musical sessions with my veena and enjoy playing it. My desire to be in the chemistry department throughout my career by taking it as my major paved the very first step to contribute my poem for "chemmmunique" magazine. I look forward to more such opportunities where I can contribute to the writing community and also take this moment to express my heartfelt thanks to the editors for giving me this chance and also to the readers who have taken their time to read this magazine. Happy reading!"

MRIDULA R (2CBZ)

Chemistry Chemistry Chemistry
It's all a path of mystery,

And it is not too strict
Like physics or mathematics,

All the experiments of Bohr, Rutherford and curie
Created the magical results as their theory,

But they all left behind some mysteries untold
its- which will hopefully unfold,

It has a family of 118 members
Who always unite to react with maximum number,

They not only react and form compound
Rather thrive in each and everything around.

This mystery might seem difficult to memorise
However, it becomes the easiest when you daily exercise,

Try voicing out the doubts that arise
in your mind
Before your knowledge is jeopardized,

There is no product formed without the reactants
Likewise, the mystery behind chemistry cannot be unboxed without the hunt,

Chemistry chemistry chemistry
It's all the path of a beautiful mystery.

Painting

"My name is Dakshayani A. I live in Bangalore. I'm doing my bachelor's in biotechnology, chemistry and botany. My interests include science, art and learning guitar. I'm very passionate about being an artist. My hobbies are drawing, painting, sculpting and reading fantasy novels. To me art is a big catharsis, it has helped so much through my hard times. I started my art journey at the age of five. I'm quite enthusiastic about learning and discovering new things which explains my decision of taking up science stream. My ambition in life is to become a research scientist. Besides having interest in science, I also want to become a self-employed artist and would love to share the joy of art to interested people."

DAKSHAYANI A (6BCB)


1940739 SBCB

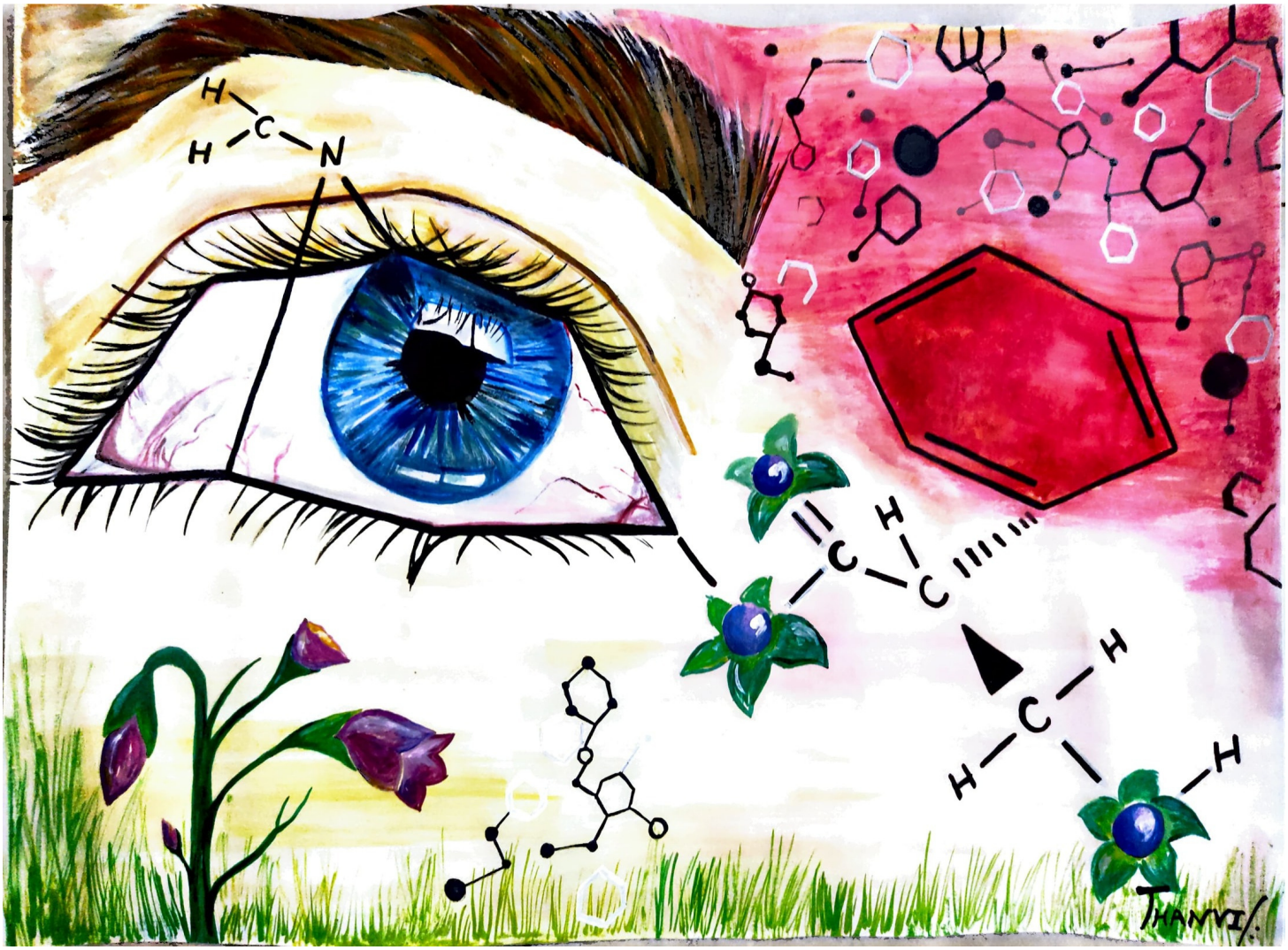
Beautiful yet lethal!

The Chemistry behind Altropa Belladonna

MUTHAMMA PT (4MAC)

The painting illustrates the relationship between art and chemistry. The artwork conveys the effects of atropine a hallucinogenic and poisonous organic compound present in the small plant called Atropa belladonna. The name belladonna comes from the Italian word meaning beautiful lady. In the olden days, the juice from the plant's berries was used to dilate the pupils of the eyes, making them appear more appealing. Though the plant had these beautiful characteristics, being a part of the toxic family, excess doses of the plant lead to serious effects and sometimes death.

The painting displays the use of deadly atropine in the form of eye drops to dilate the women's pupil. The artwork includes tropane ring and oxygens which are present in the atropine compound. It should be noted that the oxygens are displayed in the form of blueberries of the belladonna plant. The atropine contains a chiral carbon and two enantiomers of hyoscyamine have been created due to the placement of the benzene ring and hydroxymethyl group. Hence, these tropane alkaloids consist of a tropane ring which is made up of the nitrogenous bicyclic organic compound that is responsible for the poisonous effects of the belladonna plant.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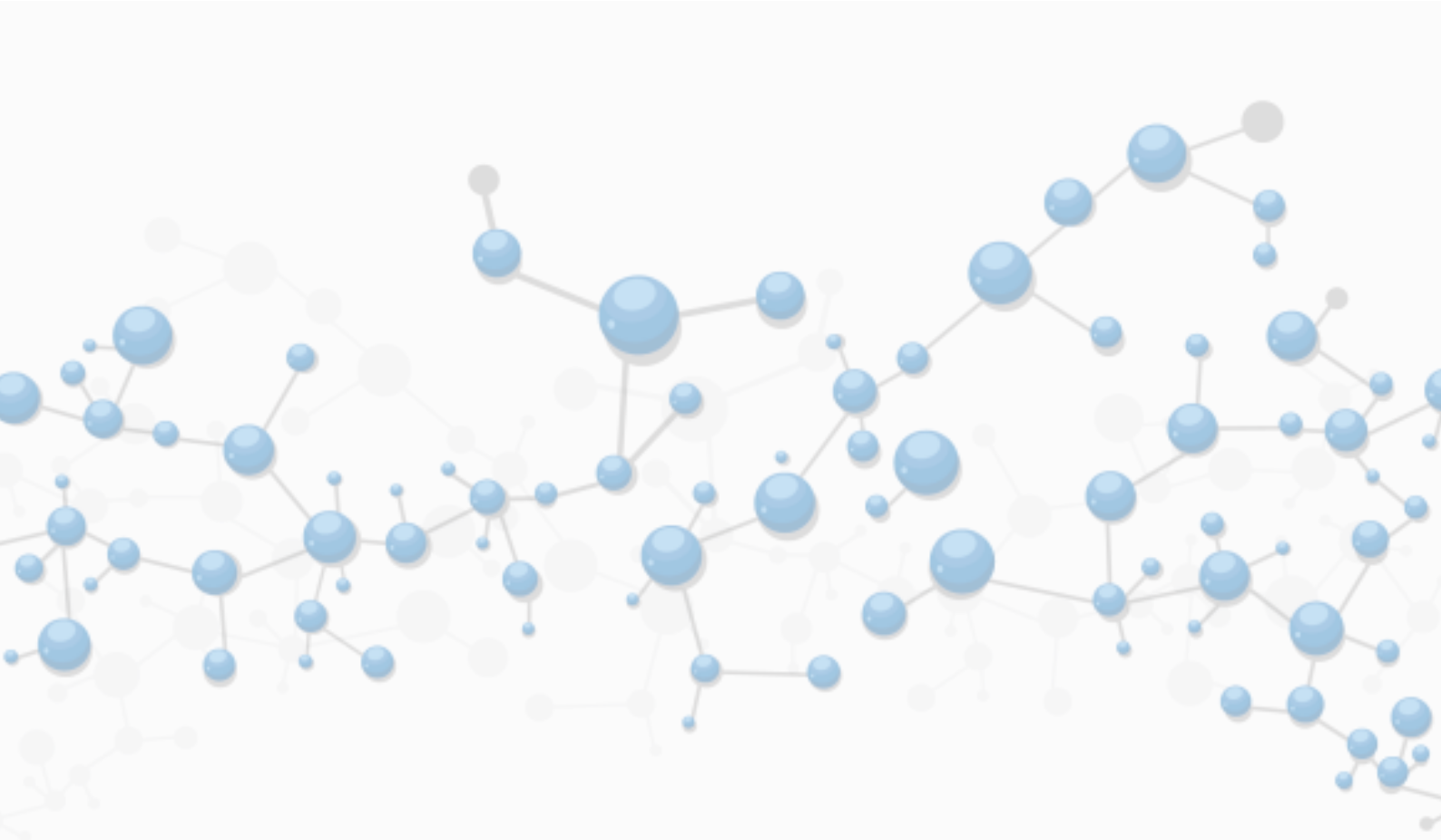
THANVI

Fun with Chemistry- Nanoputians

"I'm Francis. I'm a fun-loving guy who is into Chemistry, football and taking trips."

Francis Naveen (2MCHE)



Imagine kids, scholars, and athletes locked up in jars in a lab. Seems straight out of a sci-fi movie with an evil professor, doesn't it? Technically that's what Dr. James Tour et al. of Rice University, Texas have did with the synthesis of Nanoputians in 2003 as part of a chemistry outreach program. But Dr. James Tour isn't an evil professor with wicked plans to make robots take over the world. He prepared Nanoputians which are organic molecules whose structural formulae resemble human stick figures. Eg. Nanokid. These anthropomorphic molecules are just a few nanometres big. The word Nanoputians is derived from two words: Nanometres and Lilliputian, the former indicating their dimensions, and the latter from Jonathan Swift's popular novel Gulliver's Travels which refers to dwarfs inhabiting the fictional island of Lilliput.

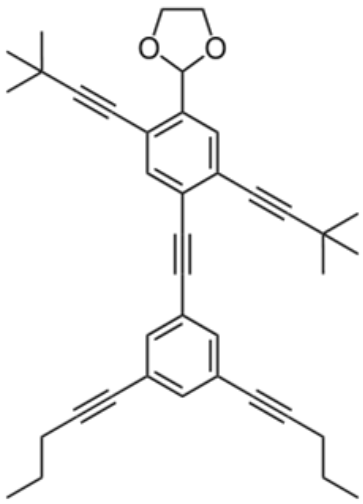


Fig 2.1 Nanokid

Structure of Nanokid

Chemistry is fun but not everyone feels so and that's a fact. Structural formulae can be rather intimidating to the masses especially children. Very few compounds like Fullerenes or Housane stay in the mind of people because their structural formulae resonate with objects in daily life. This is exactly why these scientists thought of designing a compound that would resemble humans as part of their Chemistry Outreach Program. After all, chemists are a bunch of atoms studying atoms. They even went on to make animated videos with their Nanoputians in which they are seen explaining chemistry concepts like chemical bonding to make learning more enjoyable. And it did pay off. As per studies conducted in Ohio and Kentucky, the use of Nanoputians to teach concepts increased understanding of materials presented by up to 59%! And a whopping 82% of students found learning science using Nanoputians more interesting. Moreover, the videos provided teachers with conceptual tools to effortlessly and lightly explain topics like Nanotechnology and invoke interest in the same.

The term nanotechnology also is intimidating for some and is considered to be rocket science in the nanoscale. In conclusion, their chemistry outreach program can be considered highly successful. To watch videos of Nanoputians please visit https://cohesion.rice.edu/naturalsciences/nanokids/videos.cfm

Structure of Nanokid

The 'body' is made of 2 Benzene rings joined by a few Carbon atoms. 2 units of 3,3- Dimethylbutyne are the 'arms' of Nanokid. 2 units of 1-Pentyne act as the 'legs' of the Nanokid. A 1,3-Dioxolane ring forms the 'head' of the Nanokid.

Synthesis of Nanokid

Though they appear to be stick figures, a complex synthetic strategy goes on behind the screen to come up with them. The synthesis is done in three phases. The Upper body of the Nanokid is synthesized first and then the Lower body is made and finally, they're attached at the right position to complete the body. Therefore, it is a convergent synthetic strategy.

Upper body of Nanokid

The precursor for the synthesis is 1,4-Dibromobenzene. It is Iodinated at the 3rd and 6th positions in concentrated Sulfuric acid. This Iodination serves as the point of attachment for the 'arms' and gets replaced by the 3,3-Dimethylbutyne units after a Sonogashira coupling reaction.

The resulting structure is formulated using n-butyllithium and is quenched using DMF to replace the Bromine atom at the 1st position with an aldehydic group.

This is then treated with Ethylene glycol with Toulenesulfonic acid as a catalyst which results in the formation of a protecting acetal group (the 1,3-Dioxolane ring) at the aldehydic Carbon which forms the head of the Nanokid.

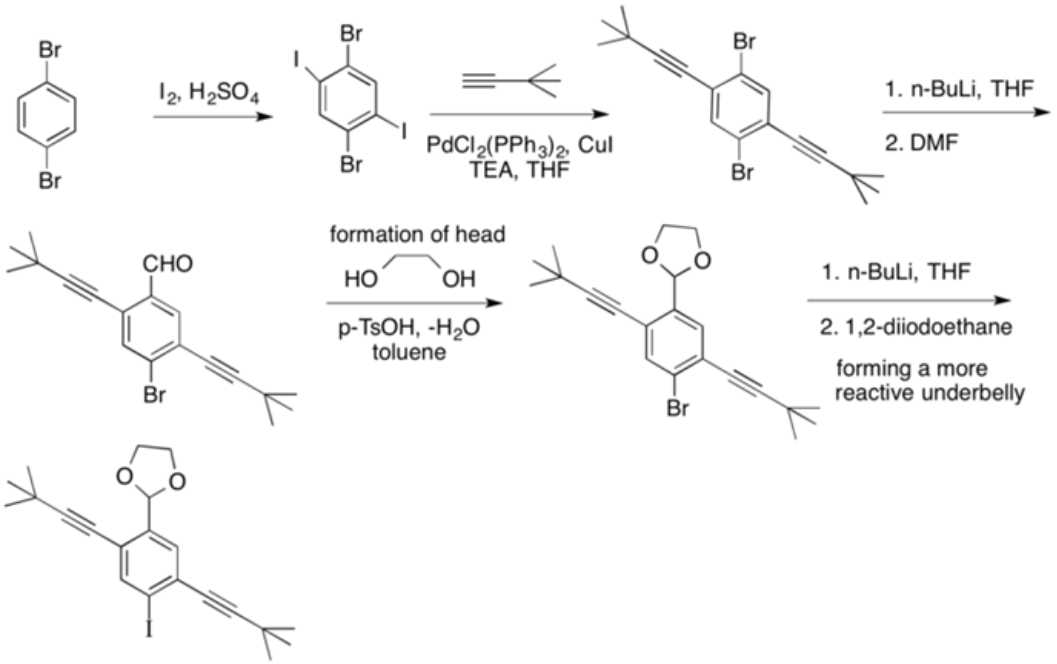


Figure 2.2 Reaction for upper body of Nanokid

Lower Body of Nanokid

p-Nitroaniline is the starting material. It is brominated at the 3rd and 5th positions in Acetic acid.
The Amino group is removed using a combination of Sodium Nitrite, Sulfuric acid, and Ethanol. This is Sandmeyer's reaction where the Amino group gets converted to a Diazonium leaving group.
The Nitro group is reduced to an amino group using Stannous (II) Chloride in THF/Ethanol solvent.

The Amino group thus formed is replaced by an Iodine group using Sodium Nitrite, Sulfuric acid, and Potassium Iodide. This is also Sandmeyer's reaction but the leaving group Diazonium gets replaced by Iodine at the end. The Iodine group thus introduced serves as a coupling partner to attach the Trimethylsilylacetylene 'stomach' via Sonogashira coupling reaction.

2 units of 1-Pentyne which form the 'legs' replace the Br atoms via another Sonogashira coupling reaction.
Selective deprotection using Potassium Carbonate, Methanol and Dichloromethane removes the TMS protecting group and gives the final product which is ready to be coupled with the upper body.

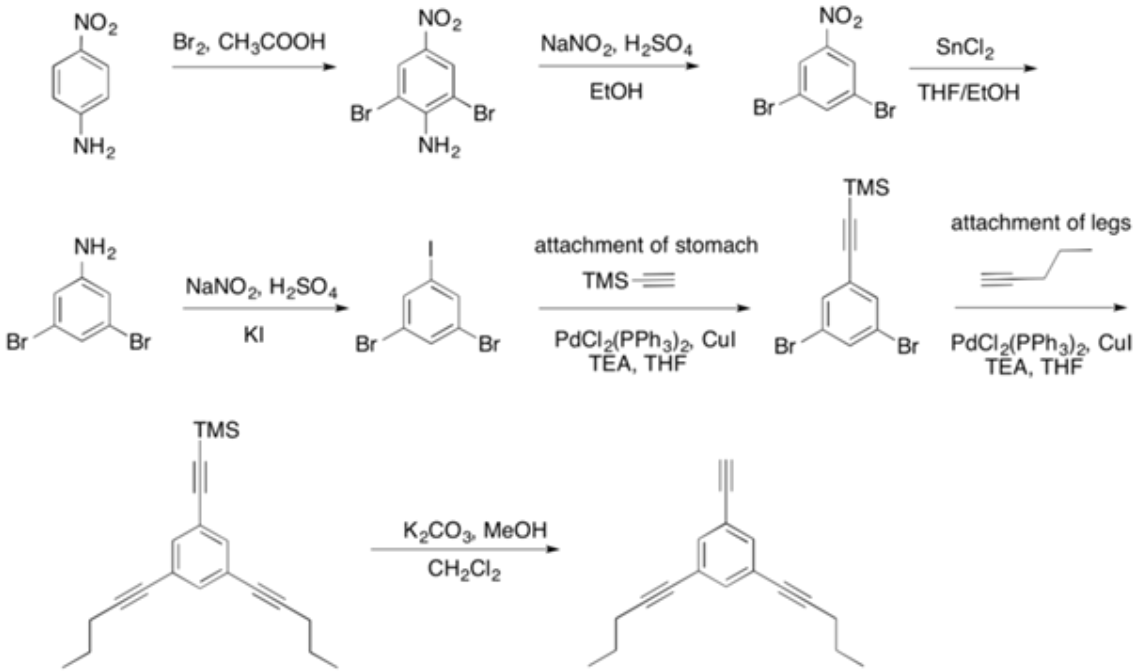


Figure 2.3 Reaction for lower body of Nanokid

Attachment of Upper and Lower Body

The two components produced are coupled by adding them to a solution of bis(triphenylphosphine)palladium (II) dichloride, Cuprous Iodide, TEA and THF

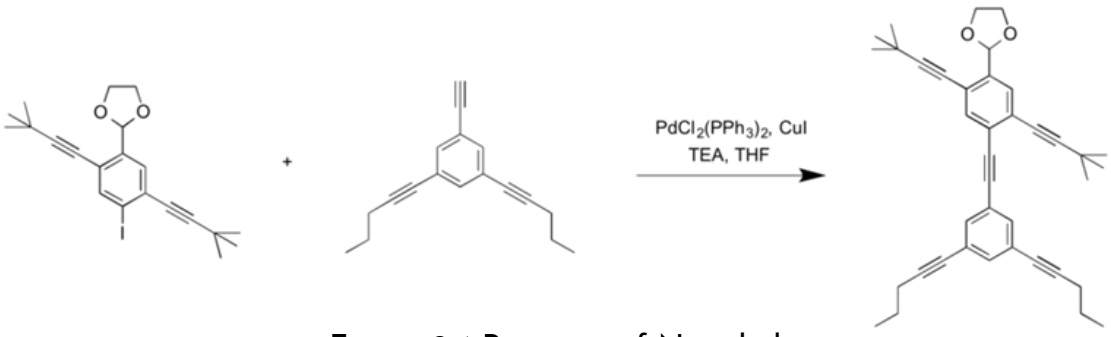


Figure 2.4 Reaction of Nanokid

Derivatives of Nanokid (Other Nanoputians)

Only the 'head' differs from Nanokid for other Nanoputians. They can be easily synthesized from the Nanokid by an acetal exchange reaction with the desired diol using para-Toluene sulfonic acid as a catalyst and heated by Microwave irradiation

Uses of Nanoputians

To this date, there is no known use of Nanoputians. However, 'to bring the molecules to life', the research team dissolved the Nanokid compound in 2-Propanol and this solution was injected into the cartridge used to print the structures of the Nanoputians.

Nevertheless, the impact of Nanoputians is immense. It has made learning fun and has evoked interest in the new generation to explore chemistry and nanotechnology.

And to those who think research work is hectic and tedious, this molecule is an example of how fun passion drives research and reiterates that Chemistry can be fun.

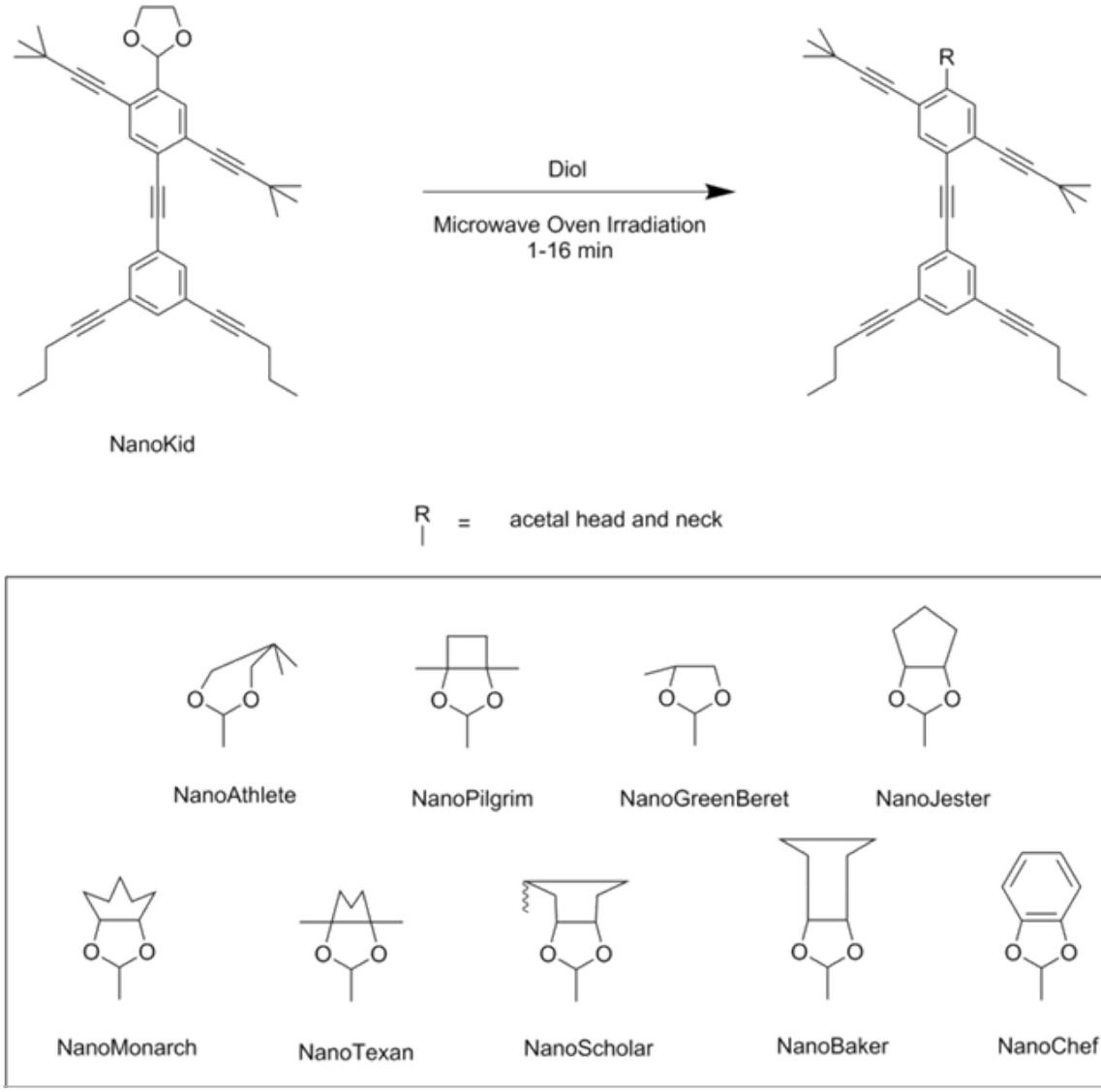


Figure 2.5 Nanostructures

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Nanotechnology in Solar Cells and Fuel Cells

"My name is Sneha Ravi Kali. I am pursuing my Bachelor of Science in Physics, chemistry and mathematics at Christ University. I am keen to study and work on various topics in cosmetic chemistry, green chemistry, and radioactive chemistry. Apart from education, I pursued karate for most of my childhood. I also love playing badminton and basketball"

Sneha Ravi Kali (6PCM)

Using non-renewable-based innovations is presumably the fundamental reason for the increase in contamination and ozone-depleting substances. We have reached a point where it is essential to discover inexhaustible energy sources. This necessity for green energy sources prompted advancement in many areas including nanotechnology. Nanotechnology can be applied in the production of new products and processes to help conserve natural resources used as raw materials in the production, energy, and water industries. These products and processes have major applications in reducing greenhouse gases and hazardous wastes. Thus, nanotechnology is a promising tool for a sustainable environment.

Nanoparticles in Solar Cells

A solar cell or photovoltaic cell is a device used to convert light energy into electric energy. Making solar cells is eco-friendly and cost-efficient, which leads to them being extensively used to generate electricity. The efficiency of these solar cells can be increased by applying an external magnetic field, which accelerates the transport of charge carriers. However, it is not always convenient to incorporate an electromagnet into a solar cell device.

As an alternative, a mixture of TiO2 (titanium dioxide) paste and Fe3O4 (magnetite) nanoparticles was first deposited on fluorine-doped glass slides coated with tin oxide. Solar cells were then prepared by dipping the coated glass slides in a solution of a specific light-sensitive dye.

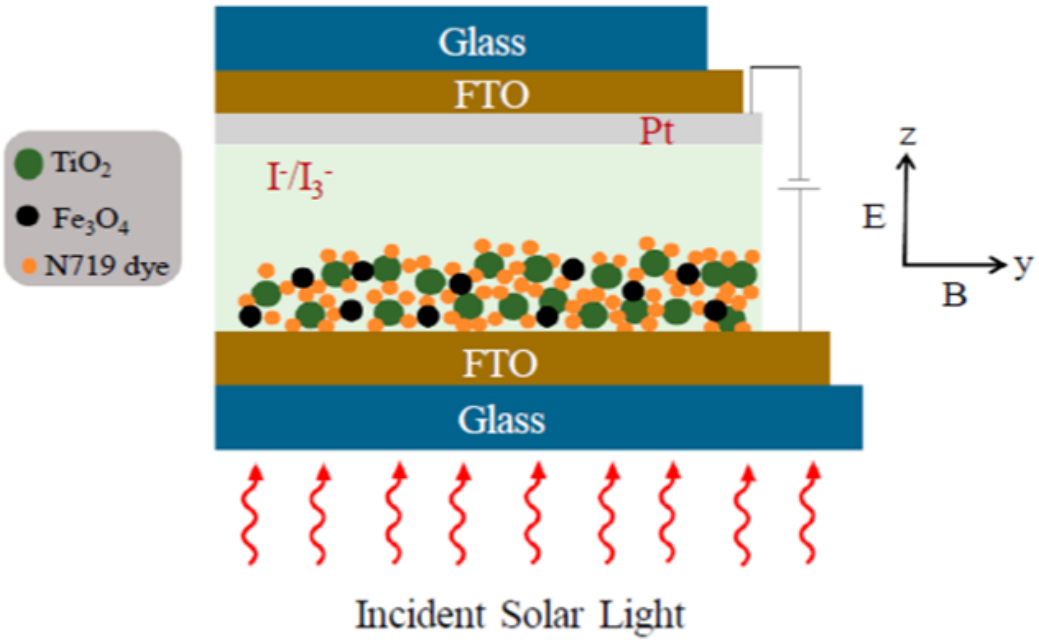

Figure 3.1 Platinum (Pt) and Fluorine doped tin oxide (FTO)

When these solar cells were exposed to light, it was found that light loss due to reflection was reduced, which led to an increase in the efficiency of absorbing light. It was also easy for sunlight to penetrate through the glass slides towards the active layer of the cells.

Nanoparticles present in the active layer have magnetic properties, which contribute significantly to the device's power conversion efficiency. An internal magnetic field generated by these nanoparticles increases the number of dissociated charge carriers, which increases the open-circuit voltage. This dye-sensitized solar cell (DSSC) can harness solar energy and convert it into electricity more efficiently than existing solar cells.

Nanocatalysts in Fuel Cells

Fuel cells are electrochemical systems that generate electricity by converting chemical energy into electrical energy. They are zero-emissive compared to fossil fuels. They are used as a power source in space crafts, air crafts, and long-distance space probes.

A fuel cell consists of two electrodes separated by an electrolyte. This electrolyte allows hydrogen ions to pass through it but not electrons. Hydrogen and oxygen are used as fuels in this system, and the combustion product is water. To make a fuel cell work, a catalyst that facilitates the electrochemical reaction of hydrogen and oxygen/air is required. The most commonly used catalyst is platinum, but it is expensive and limited in supply. To have fuel cell-powered vehicles possible, we need an alternative that is better and less expensive.

Palladium is an element that chemically resembles platinum. It is extracted from copper-nickel ore and is currently used as a catalyst material in the catalytic converters of automobiles.

Palladium is also 75% less expensive than platinum. When used in nanoscale in direct methanol fuel cells, it demonstrated an increased power density of 45%. Palladium catalyst exhibited improved selectivity and its being in nanoscale provided additional surface area. Both these factors led to a dramatic improvement in the efficiency of the catalytic reaction. So, palladium as a catalyst is both less expensive and leads to better performance.

Conclusion

Nanoparticles and nanocatalysts play an essential role in the development of a sustainable energy production system due to their unique properties. We can conclude that nanotechnology can help in developing green processing steps along with efficient yield in an economical condition for the production of several biofuels as the sources of bioenergy.

Reference

[1] Kumar, R. Praveen, and B. Bharathiraja, eds. Nanomaterials: Application in Biofuels and Bioenergy Production Systems. Academic Press, 2021.

[2] Kannan, U. M., L. Giribabu, and S. Narayana Jammalamadaka. "Demagnetization field driven charge transport in a TiO2 based dye sensitized solar cell." Solar Energy 187 (2019): 281-289.

[3] Pandiyan, G. Karthik, and T. Prabaharan. "Implementation of nanotechnology in fuel cells." Materials Today: Proceedings 33 (2020): 2681-2685.

The Chemistry Behind the Origin of Life

"My name is Prapti, I am a second-year undergraduate who is extremely interested in fields of Biochemistry. Since childhood, chemistry and biology have influenced and taught me a lot of different things to learn about and explore. I have always pictured myself doing something practical and both these subjects have immense of work happening especially when intertwined. In my free time I like playing basketball and reading science related books which help me broaden my thoughts and learnings. I also enjoy meeting new people and knowing about different cultures and places!"

PRAPTI CHAKRABORTY (4CBZ)

We all know from our textbooks and general knowledge that life is sustained and obtained from the DNA or protein world. Some studies said and stated the presence of RNA world. Synthetic organic chemistry played an extremely important role in telling us and explaining to us about the building blocks of how we rose from early Earth. We all have come across the Miller-Urey experiment which has tried to explain to us about various attempts of the creation of life. Compounds such as Methane, Ammonia, and Hydrogen were circulated across and over boiling water.

Some electrodes were also introduced to give a setup for mimicking lightning. After a certain point of time, there was the formation of amino acids was detected. But was that the way how the earth was created?

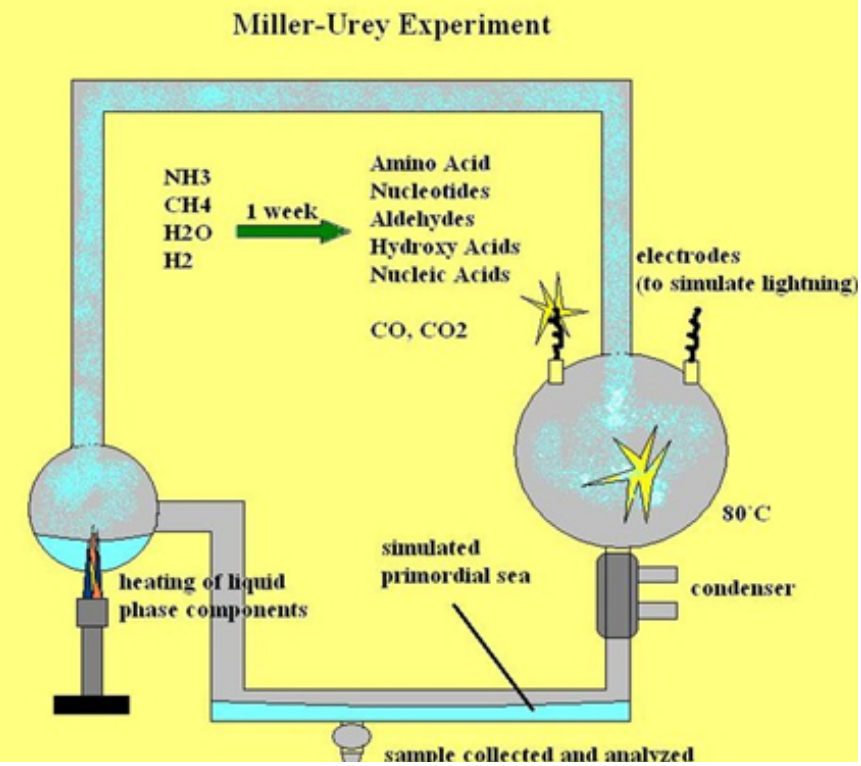

Figure 4.1 Miller Urey Experiment flowchart

Imagine if due to the early reducing nature oxygen was absent and no oxygen means no ozone. No ozone means that there was no protection against the UV rays. Thus, it can be assumed that this huge energy produced by the rays could drive the early reactions. As the tiny molecules were formed, their concentrations slowly increased and they slowly dissolved into the early water bodies such as oceans. These molecules could collide to form polymers but that is a little too unlikely. But the studies show that the molecules adhere to clay particles in the water and form the elements as we know them today. Aluminum, Iron, Magnesium, Calcium, and many more also helped catalyze early reactions.

The synthesis of various organic and inorganic molecules was a need for the survival of organisms on earth. The oceans being so vast could not give us determined scales for the synthesis. Due to this, there has been a variety of studies which has told us about the processes of how the molecules could have been selected and concentrated to give rise to the structures of life. There was a term called Molecular self-organization which was said to give rise to the long slender building blocks of membranes called phospholipids. These spontaneously self-organize to give cell-like structures which were later introduced and explained more by Zimmermann.

This self-organization of certain molecules could be said to be the base of the first RNA-like structure. The first informational polymer could be said to have a very similar structure to RNA's. There have also been experiments that have revealed that amino acids which concentrate and polymerize to clay particles form small structures which are also the building blocks of RNA.
There was thus, a huge leap from geochemistry to biochemistry which is seen throughout the steps of evolution.

Life would have started from the creation of molecules to macromolecules to self-replicating units. A self-replicating unit like that of the RNA, promoted its replication while giving information to generations after generations.

This soon further developed to give us what we are comprised of. The 4 base-paired structures, DNA, control our characters and genetics. This chemical origin played an extremely strong role in transforming our geosphere into a biosphere.

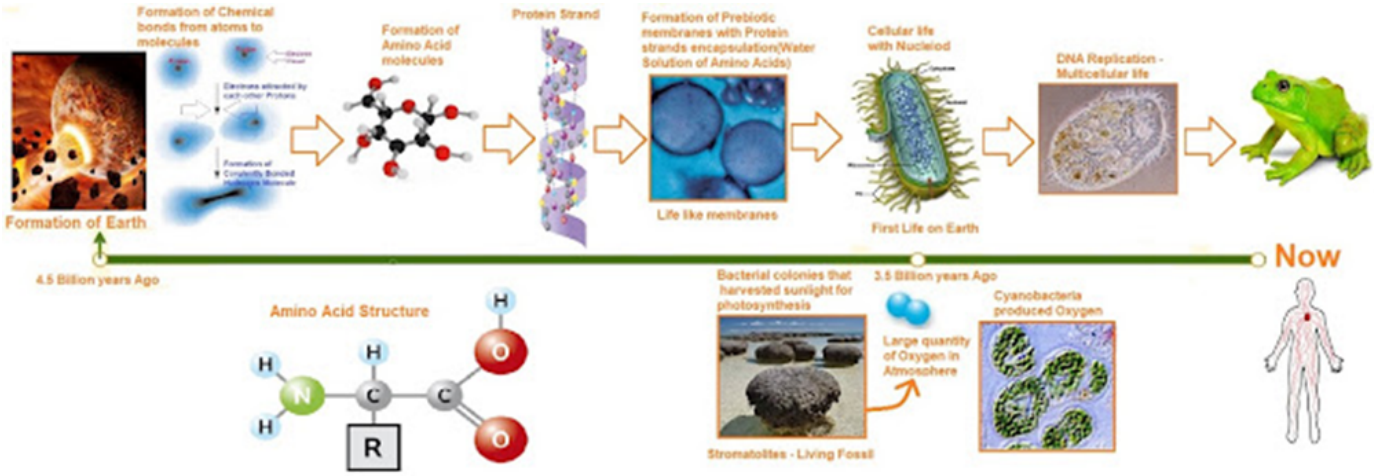

Figure 4.2 Evolution of DNA

Overview of Asymmetric Organocatalysis

"Currently pursuing my masters in Organic chemistry in CHRIST (Deemed to be university), Bangalore. I did my Bachelors from St Joseph's college, Bangalore. In search of happiness after learning something new. Many aspects of chemistry are very much relatable to our life, is something that has interested me to pursue in this field. Just as nucleophile, let's have high charge less electronegativity in our life. Don't let anything sterically hinder you. Being spontaneous as a nature's choice and having moderate entropy in learning is always fun. About my side-lines, I love playing carrom, outdoor games and a Natures friend."

TEJASHREE PRAKASH (2MCHE)

In the study of chiral transition metal catalysts, organocatalysts were reported in the year 2000 [1]. In the present year 2021, this field of chemistry has created a benchmark by two scientists namely Benjamin List and David W.C. MacMillan "for the development of asymmetric organocatalysis". In an attempt, with great enthusiasm of appreciation, we shall further enable our understanding of the same.

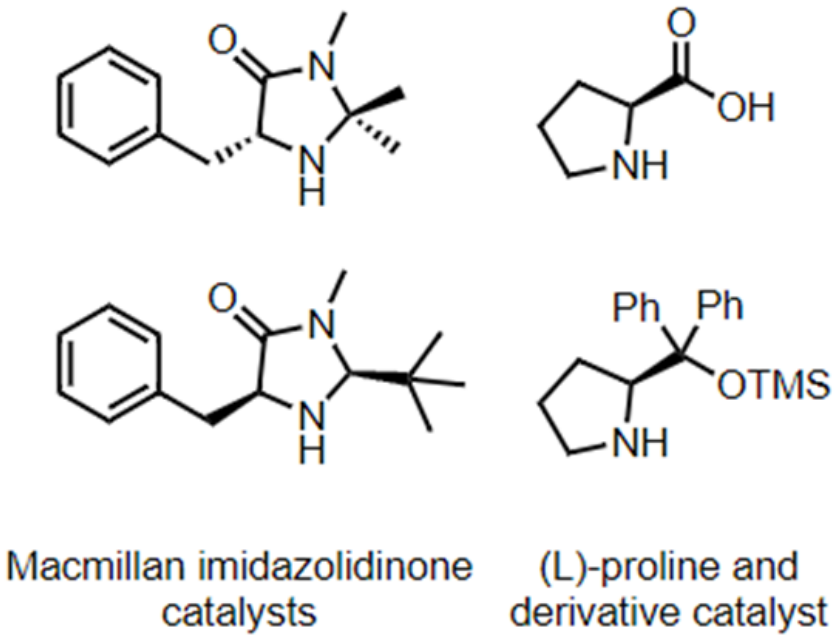

Fig 5.1 MacMillan's ever-growing family of catalysts, and the proline and derivatives used by List and others, have shown that organic molecules can complement metals and enzymes

Introduction

- In 1912, Bredig demonstarted alkaloid catalysed enantioselective synthesis of cyanohydrin
- In 1960s, Pracejus described organocatalysts acts as prominent enantioselectives
- In 1970s, Groups by Hajos and Wiechert reported first efficient enantioselective aldol reaction through proline- a simple amino acid
- In 2001, field of transition metal catalysts led to Noble prize in Chemistry

We know that enzymes are selective and specific. Many chemists chose metal-based catalysts and chances of finding active metal sites for binding enzymes were comparatively less. Over biocatalysts and metal complexes, small organic moieties, organocatalysts were considered efficient and enantioselective catalysts.

Small organic molecule catalysts are called organocatalysts. Organocatalysts are pure organic molecules that remove or donate either electrons or protons in substrates or transition complexes[2]. Mostly organocatalysts can be classified as Lewis acid, Lewis base, Brønsted acid, or Brønsted base.

Catalysis of Lewis acid

Phase transfer catalysts are the major group of Lewis acid catalysis. The first phase transfer chiral catalysts were developed between N-benzyl cinchoninium salt and indanone for asymmetric α-methylation with an efficient yield of 95% and 92%. Similar work was carried out between cinchonine and cinchonidine-based catalysts for α-alkylation among glycine derivatives to give enantioselective α-amino acid. Later efficient asymmetric induction of 99.5% was achieved between N- anthracenyl cinchonidine salts in α- alkylation among glycine derivatives..

Catalysis of Lewis base

The organocatalysts include P-, N-, C-, O- and S- Lewis bases that follow different mechanisms involving conversion of substrates into activated nucleophiles

such as carbonyl compounds or electrophiles. Iminium ions, acyl ammonium ions, enamines are the intermediates present in mechanisms.

Catalysis of Brønsted acid

Generally catalysis of hydrogen bonding is prominent. Others include Strecker, Mannich, Pictet-Spengler reactions of imines, activating to form hydrogen bonds. A group of Takemoto co-workers described that bi-functional organic catalysts i.e; chiral thiourea derivatives and their neighboring tertiary amino acid groups activate nitro compounds for enantioselective reactions of Micheal and aza-Henry.

Catalysis of Brønsted base

Some examples based on asymmetric catalysts are hydrogenation reactions, such as synthesis of cyanohydrin; Strecker reaction; Michael reaction; desymmetrization of cyclic Meso-anhydrides. A group of Lipton co-workers used cyclopeptide as catalysts in Strecker reaction among N-benzhydryl imines to α-aminonitriles[3].

Advancements over a decade includes discovery of novel catalytic modes, reaction types , electrocatalysis, artificial intelligence, activation of inert substrates and various target oriented establishments in organocatalysts. New emerging field of asymmetric organocatalysis will grow to make much more benchmarks coming years through its efficient yields[4].

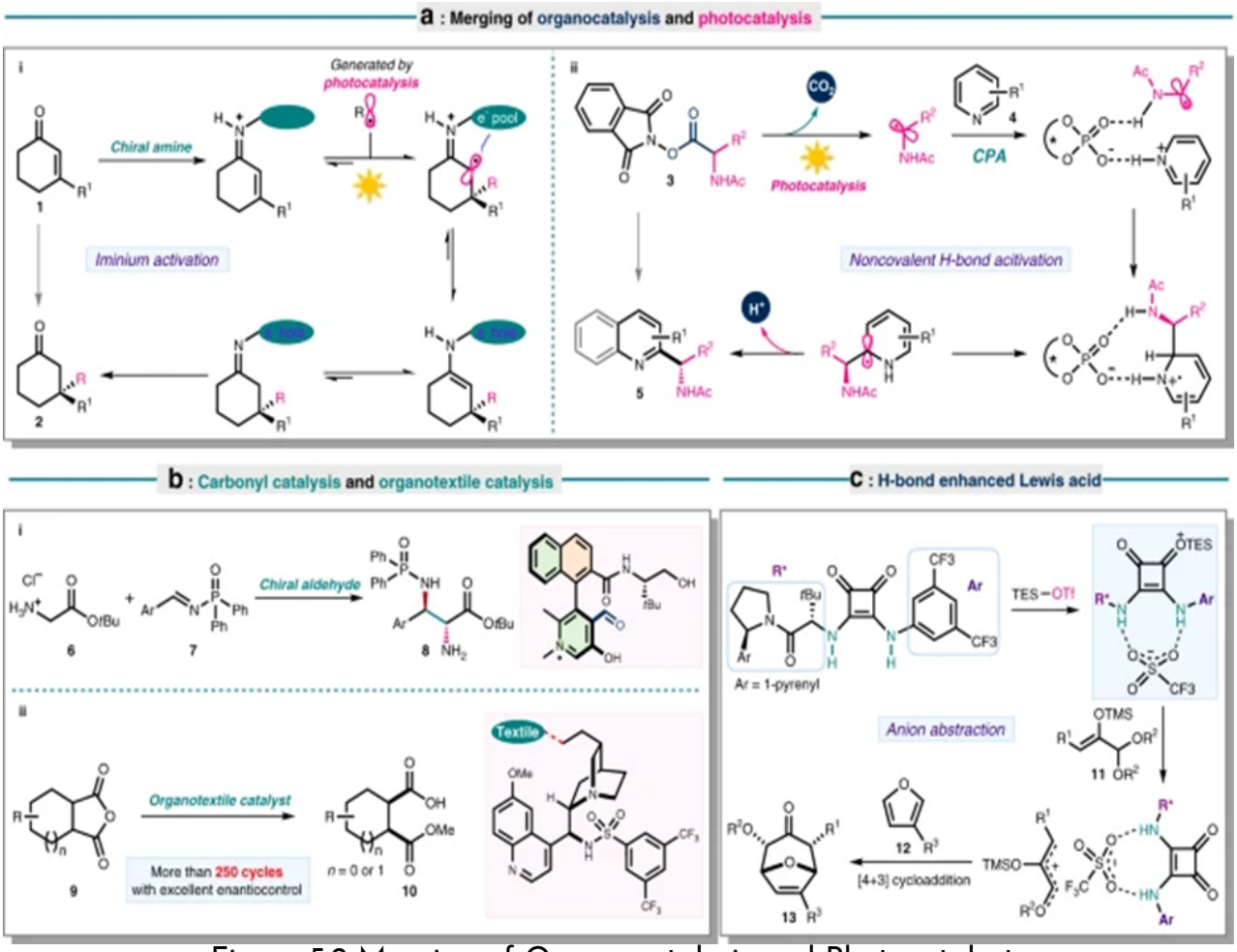

Figure 5.2 Merging of Organocatalysis and Photocatalysts

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Seeing is Believing

"I am Lisa, an ordinary (sometimes curious) student. I like the way how science explains almost everything around us by proposing theories explaining them logically and then testing them through experiments. It is highly trustable! I have had a strange inclination towards music from childhood, suddenly out of nowhere I get tunes in my mind. I like to pass time looking through the lens of science and also dancing to the tunes I get."

LISA.B (6PCM)

Roses are red,
Violets are blue,
These colors we see,
Are they illusions too?
One of the most perplexing things in the universe that has left people through the ages in a state of enigma is 'Light'. Where does this light come from? Does it flow? Has it been there forever? How can it cause a sense of heat? How does it travel so fast?.....etc.

It is only in the last century that we have unraveled a better picture of light! Modern science answers these questions successfully today.

We started understanding light firstly when scientists or curious people began playing with prisms and lenses(you see it's a good thing to play around). We found out that light while passing from a rarer to a denser medium disperses into various wonderful colors. Things further changed when William Herschel discovered infrared radiation while measuring temperatures along the visible spectrum, it was clear that light had components beyond what the eye could see.

Animals(including humans of course) are endowed with complicated body mechanisms. Just take a look at yourself, the sense of touch, smell, taste, hearing and seeing, workings of various organs to carry out functions like respiration, circulation, digestion, excretion, and locomotion are all so so so sophisticated and often taken for granted.

Chemistry underlies almost everything!

The eye is a true wonder. If you happen to doubt try doing everyday chores with your eyes closed. It won't take you long to realize. .

Now how is it that we can see different colors? Does every living creature gifted with the sense of sight see things exactly the way we do?

We are aware that when light rays strike an object some part of it (in terms of wavelength) is absorbed while the other is reflected and this primarily determines what we can see.

So when we look at a Rubik's cube we see 6 different colors and this is because the wavelength of light corresponding to these colors is reflected off the surface of the respective pieces of the cube. The egg (any white object) appears white, as it reflects all the incident light, while a blackboard is black as it absorbs all the light and reflects none.

Once the reflected ray reaches the eye it passes through the pupil and is focused by the lens onto the retina. The retina is a light-sensitive detector that hosts millions of photoreceptive cells called rods and cones.

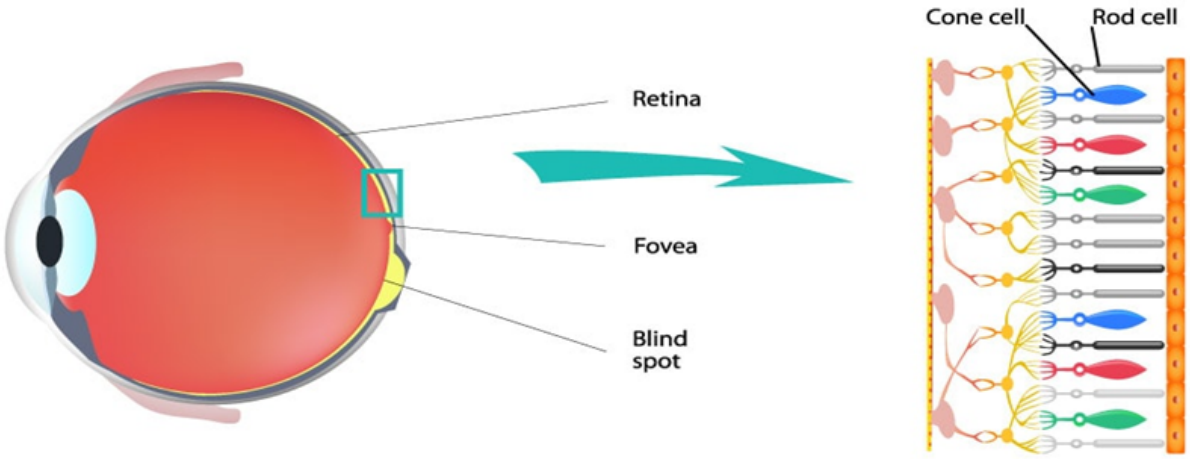

Figure 6.1 Perception of light by the human eye

Rods and cones convert light into signals that are interpreted by the brain. There are about 7million cones and 120 million rods in the eye. Rods work in dim light or nearly darkness, while cones are 100% responsible for color vision.

There are 3 types of cones: red-absorbing, green-absorbing, blue-absorbing. These three work in different combinations and let us see different colors.

The outer segment of these cells has regions filled with membrane-bound discs which contain protein molecules bound to a molecule called 'chromophore'.

Now, what's a chromophore?

It is a molecule that is photosensitive to specific wavelengths. Chemically it's an **11-cis-retinal!**

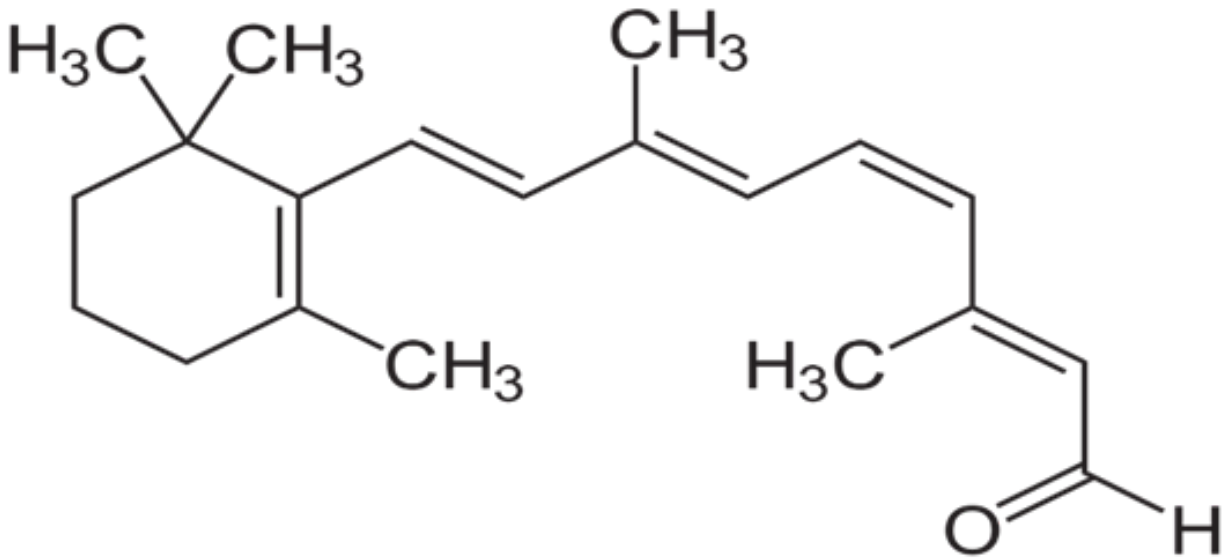

Figure 6.2 Structure of 11 cis-retinal

When light falls on this chemical it undergoes isomerization and forms **all-trans-retinal.**

Now, this new form doesn't fit well into the protein since it has a twisted conformation that is highly unstable hence a series of conformational changes occur to expel the chromophore from the protein. The shape of the protein begins to change in a few nanoseconds.

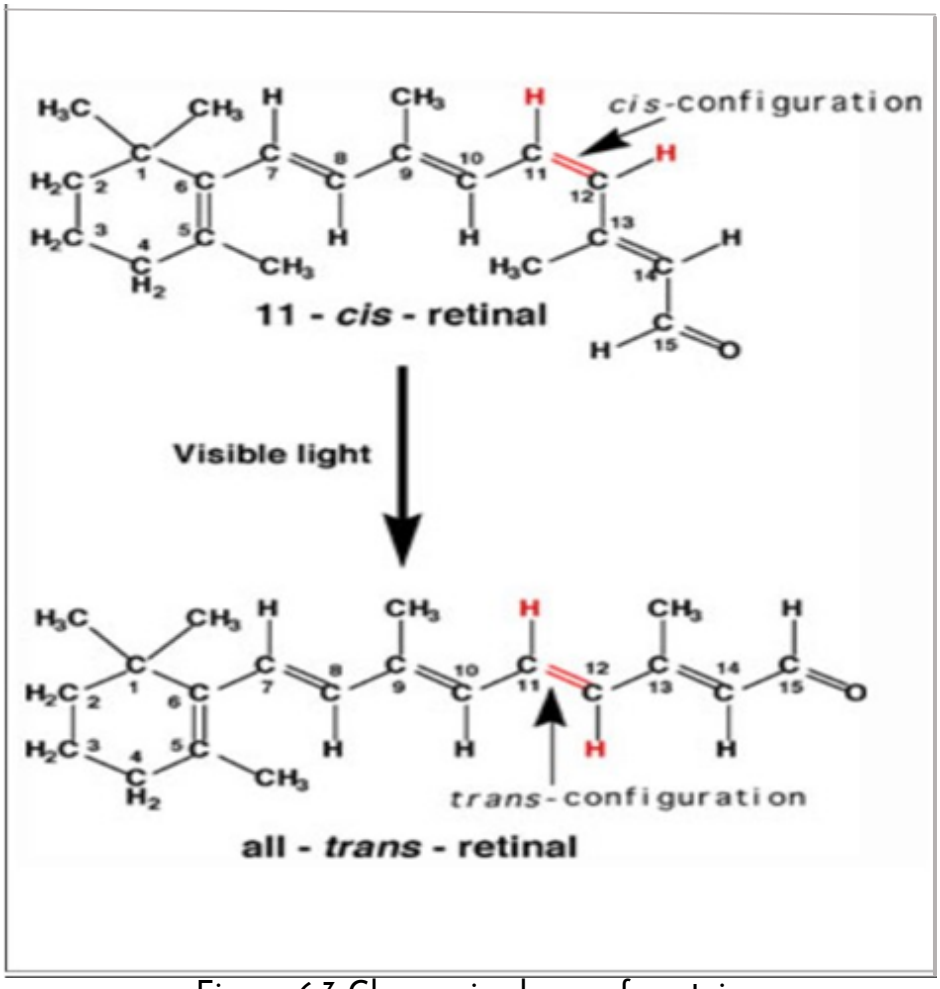

Figure 6.3 Change in shape of protein

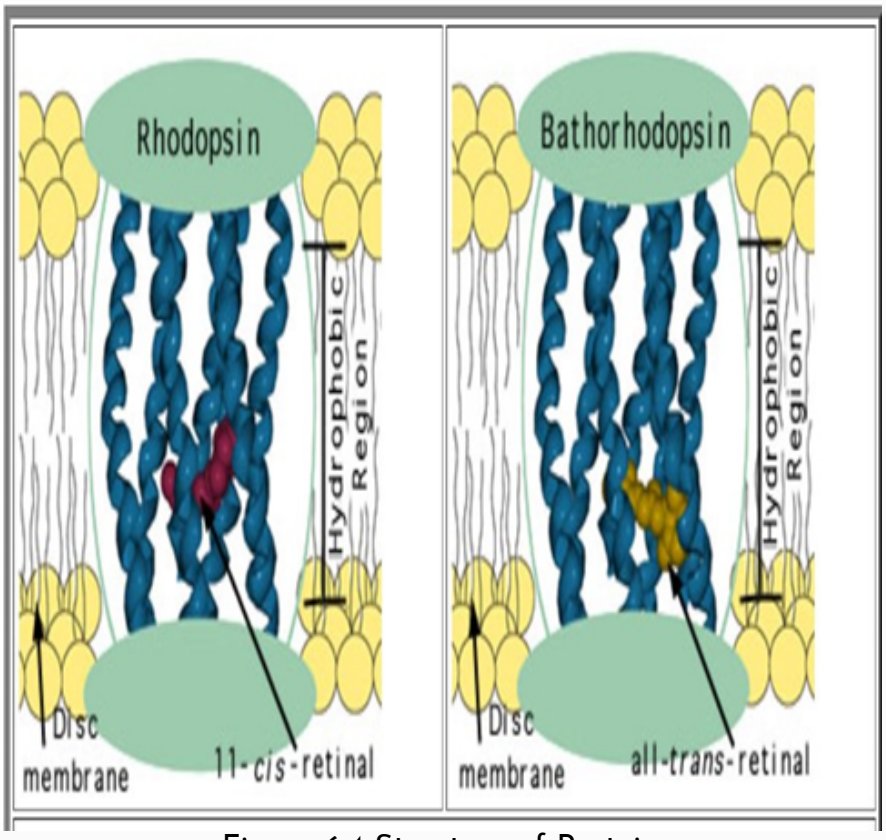

Figure 6.4 Structure of Protein

At last, all-trans-retinal is put out of the protein yielding both the molecules in free forms. During this many intermediate complexes are also formed that absorb various wavelengths of light. Chief among them is Metarhodopsin-II, which activates an enzyme called transducin which in turn activates phosphodiesterase enzyme, this catalyzes the hydrolysis of cyclic GMP.

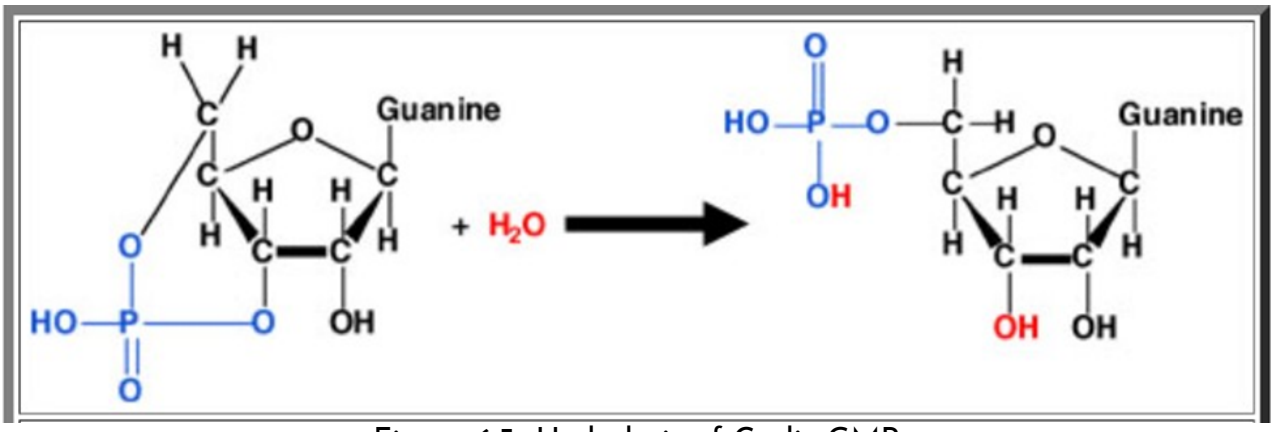

Figure 6.5 Hydrolysis of Cyclic GMP

This reaction closes the Na+ channels flowing in and out of the cells, as a result, the cell's potential becomes lesser than the surrounding. A huge potential difference is built up across the membrane. This is called hyperpolarization. This potential difference travels in the form of electric impulse through the terminal ends of rods and cones to the adjoining nerve cells and is transferred to the brain.

To detect color, the brain reads the impulses sent from the cones primarily. When we see the yellow color, both the red and green absorbing cones are at work and they send impulses accordingly. It is the brain that identifies the sites of origin of these impulses and then interprets the color accordingly.
Now for all of this complex stuff to occur it doesn't even take a second!! CRAZY RIGHT?!

Different animals have different photoreceptors that are sensitive to different wavelengths.
So what we see is reality only to us!

Let's see through the eyes of birds, bees, and snakes:

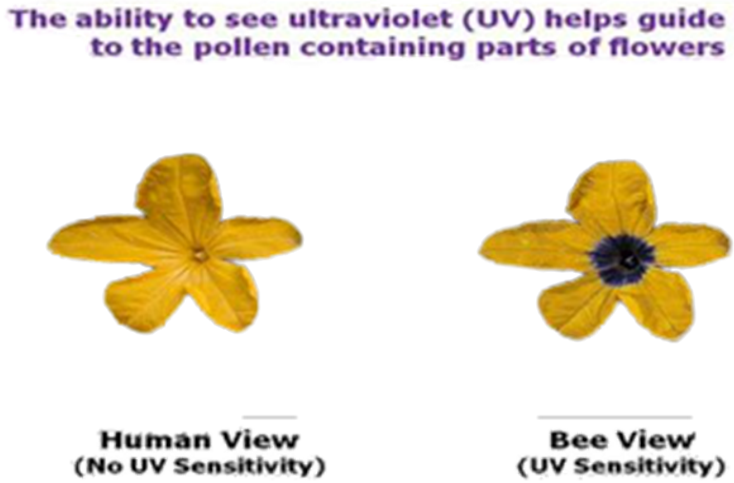

Figure 6.6 UV vision of bees that help guide them to flowers

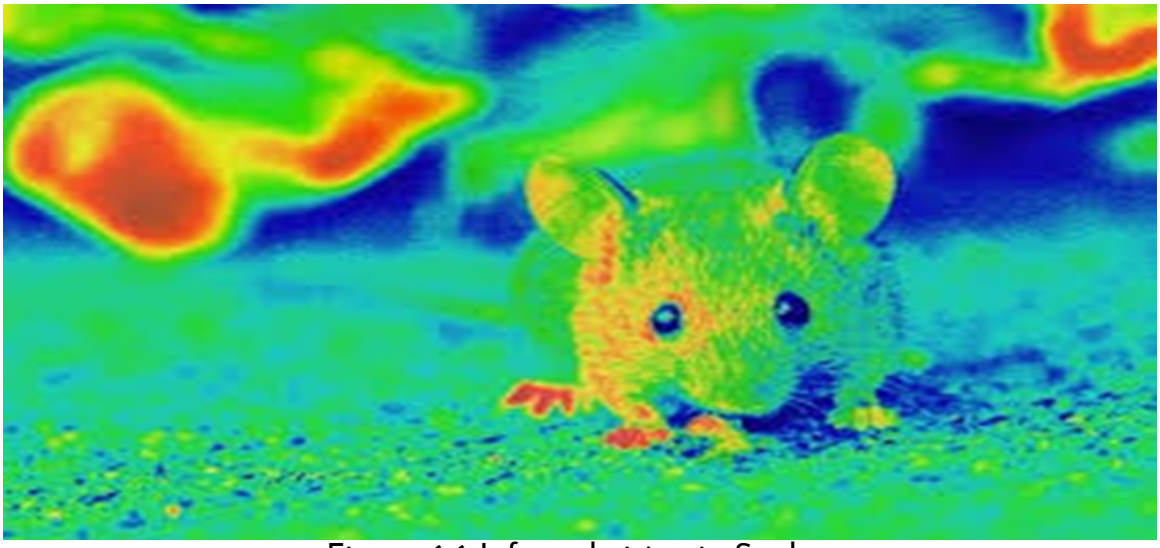

Figure 6.6 Infrared vision in Snakes

Snakes can see infrared radiations which are a result of the body's temperature.

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"I Have Seen the Light!": Vision and Light-Induced Molecular Changes, Spectroscopy and Quantum Chemistry Experiment

Authors: Rachel Casiday and Regina Frey,
Department of Chemistry, Washington University,
St. Louis, MO 63130

Formulation and Evaluation of Home Made Poly Herbal Liquid

"My self, Kiran Bijapur, I am pursuing my Chemistry master's from Christ University, my hobbies are sketching, mobile photography and watching life hack videos on YouTube, reading newspaper cutting, I am more interested in Stock markets and some other financial related things, I am always looking for an opportunity to do better and achieve greatness. I enjoy delegating tasks, I have good leadership skills, and I am the placement coordinator in the chemistry department. I am looking forward to solving issues associated with agriculture. Currently, I am doing research work on molecular sensing studies of curcumin derivatives under the guidance of Dr. Prasad Pujar. I am interested in the topics which will be helpful for the upcoming society. I am ready to apply my knowledge in researching supercapacitors, solar energy, semiconductors, Bio-ethanol.""

KIRAN BIJAPUR (4MCHE)

INTRODUCTION:

Mosquitoes are found all throughout the planet. There are numerous mosquito repellent products on the market to combat them. Mosquitoes, on the other hand, began to attack them. Not only that, but users suffer from a slew of well-documented severe side effects. As a result, a polyherbal mosquito repellent based on traditional practises and varieties available in the kitchen and garden has been developed to give dependable, long-lasting, and comprehensive protection against mosquito bites by destroying them. The action of the built-in shortcuts was tested. Artificial insemination is more effective, less expensive, and less hazardous than conventional mosquito repellents, according to the findings.

Popular mosquito-borne diseases face a global danger. Yellow fever, dengue hemorrhagic fever, pandemic polyarthritis, encephalitis, and malaria are all diseases that kill more than three million people each year, according to the World Health Organization (WHO). Mosquitoes can be found all throughout the world, except in Antarctica and France. Mosquitoes spread the disease to almost 700 million people each year, and 1 in every 17 people is responsible.

When female mosquitoes need blood nourishment (from animals or people) to create eggs, male mosquitoes prefer floral nectar. Mosquitoes that fly make a distinctive high-pitched noise that might disturb sleep. Female mosquitoes inject saliva and anticoagulants into the bloodstream. Within minutes, the human immune system has built up, and the bite is swollen and itchy, and some people are extremely sensitive to bites that produce blisters, abrasions, and serious inflammatory reactions. An allergic reaction, also known as hypersensitivity, causes visible, uncomfortable itching. This hypersensitivity is a result of the mosquito's saliva containing IgG and IgE antibodies. The need for effective insecticides is highlighted by illness and death.

2) Experimental Details

2.1. Materials Required

Ingredients	Botanical name/ Family	Active constituents
Garlic bulb	*Allium sativum (Lilliaceae)*	Sulphur, Allicin, Alliin
Basil leaves	*Ocimum sanctum (labiatae)*	Eugenol, Carvacrol
Neem leaves	*Azadirachta indica (Meliaceae)*	Nimbin, Nimbidin, Nimbinin
Ajowan seeds	*Trychyspermum ammi (Apiaceae)*	Thymol, p-Cymine,Terpene
Lemon peel	*Citrus limonis (Rutaceae)*	Limonene, Citral, Terpineol
Mentha leaves	*Mentha piperita (labiatae)*	l-Menthol, Menthone,
Cinnamon oil	*Cinnamonam zylanicum(Lauraceae)*	Cinnamonic acid
Gold flower	*Chrysanthemum cinerariifolium*	Pyrethrum
Castor oil	*Ricinus communis (Euphorbiaceae)*	Ricinoleic acid

Figure 7.1 the herbs and species used in homemade poly herbal mosquito repellent

The traditional remedies above already have mosquito repellent properties. For this project, I have chosen paraffin as a base because it has minimal mosquito repellent actions used by the people of Anantapur.

Figure 7.2 the herbs and species used in homemade poly herbal mosquito repellent

2.2. METHODS OF POLY HERBAL PREVENTION

Garlic lamp, basil leaves, neem leaves, ajowan seeds, lemon peel, Mentha leaves, gold flower petals, and cinnamon bark, crushed and submerged in paraffin overnight in the amounts listed in table 2.

Add Castor oil as shown in Table 2 and add 1 g of standard salt as a preservative and mix well. Strain the above mixture with a cloth. Transfer this setting to a blank filling. The filling is now ready for use. Various customizable formulas poly herbal mosquito repellents were.

Result

Various poly herbal mosquito repellent methods were tested by keeping them inside a net containing a group of mosquitoes for 2 h.

Each composition is tested for its effectiveness each day until all eight ingredients are tested for 8 consecutive days. The success of the design is based on the number of mosquitoes that change the location, fall to the ground, and without any specific action.

Ingredients	Formulations/ Quantity (g)							
	F1	F2	F3	F4	F5	F6	F7	F8
Garlic bulbs	2	4	6	8	10	12	14	-
Basil leaves	1	2	3	4	5	6	7	-
Neem leaves	1	2	3	4	5	6	7	-
Ajowan seeds	1	2	3	4	5	6	7	-
Lemon peel	1	2	3	4	5	6	7	-
Mentha leaves	1	2	3	4	5	6	7	-
Gold flower petals	1	2	3	4	5	6	7	-
Cinnamon bark	1	2	3	4	5	6	7	-
Castor oil	1	2	3	4	5	6	7	-
Common salt (NaCl)	1	1	1	1	1	1	1	1
Kerosene up to(ml)	25	25	25	25	25	25	25	25

Figure 7.3 Various formulae of homemade poly herbal mosquito repellents

It was found that among all the constructions, F7 showed better performance as it led to the fall of 52.63% of mosquitoes, 42.1% of mosquitoes changed their location and only 5.26% of them showed no response to mold.

4. HELP TO THE COMMUNITY

Consumers are marketed a variety of chemical goods and other pollutants. We sought to see which natural antibodies offer long-term protection against mosquito bites. We are developing mosquito repellent on our garden plants based on the culture and species of the animals by looking at mosquito repellent ways. Are readily available in the kitchen to provide 100% effective and long-lasting protection against mosquito bites. It is more effective, less expensive, and less poisonous than the chemicals currently on the market, such as Pallethrin and Allethrin.

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Soaps and Sanitisers

"Hi guys! I am Akshata from 6BCB. Chemistry interests me in the components of this world. In these challenging times, we came across many new things. Many things were introduced for safety of the people. Sanitizers is one common commodity in our daily lives now. I have tried to suffice my curiosity about their chemical nature through the infographic that I prepared seeking various sources. Hope it suffices yours too."

DESHMUKH AKSHATA (6BCB)

Soaps and sanitisers are the common things we are using in our daily life. Their use has immensely increased after their utmost need during these challenging times. But what is their chemical nature? How doeos it work? Lets ponder about it here.

What are soaps?

Soaps are potassium or sodium salts of long chain fatty acids made by hydrolysis of fats through the process known as saponification.
What are Hand Sanitizers?
Hand sanitizers are generally liquids or get used to kill pathogenic microorganisms. The major constituent in them is alcohol. They also contain humectants and excipients. Humectants are used to avoid dehydration of skin and excipients are used to increase the evaporation time of alcohol.

Use of excipients increases the evaporation time of alcohol in sanitizers that increases the biocidal tenure and activity of alcohol.

How do soaps work?

Soaps have hydrophobic head. The hydrophobic tail interacts with lipids and organic material like grease as it is non polar and because of the rule, 'like dissolves in like'. As more and more soap molecules interact with grease, it forms a micelle structure with hydrophobic tails attached to dirt, whereas hydrophilic head towards the polar water solvent. Thus it forms the emulsion of soap and dirt in water which is removed from the dirty surface on cloth upon agitation.

How do sanitizers work?

The 60-70% alcohol concentration that is present is responsible for biocidal activities due to dehydration, cellular disintegration and its affect on essential metabolic activities lead to death of bacteria. The above mentioned concentration of alcohol is more efficient in killing the bacteria than absolute alcohol as it prolongs the time of contact and hence gives more time for alcohol to act on bacteria.
In case of viruses, the ethanol acts on the viral envelope which encloses the infective genetic material. The envelope is made up of lipids derived from the host cell and the capsid protein.

Benzalkonium chloride is the major constituents of non-alcohol based hand sanitizers, it has been seen that it is a bit effective agent against the non-envelope viruses as well it acts on the membrane of bacteria or virus and hinders the essential mmetabolism.

Which one is better? Soap or Sanitiser?

Use of hand sanitizers is less efficient compared to the use of soap. Use of soap is recommended over hand sanitizers to remove the bioburden over hands and to act against a wider spectrum of microorganisms. Also it has been experimentally observed that washing hands with soap and water also acts against the non-enveloped viruses like noroviruses. But some scientists also say that use of soap removes the lipids over the skin produced by our body, which in turn creates a path for the microbes to enter from within the skin. Thus, to prevent this, use of hand sanitizers wit emollients in it is recommended by some scientists.

Ida Noddack

""I am a 2 nd year student of PCM. Chemistry has had my heart since class 7 th when it was first introduced to me. I'm currently pursuing organic chemistry research going on in the department while also preparing for my first ever review article. I'm proud to be a woman in STEM and the hope to inspire more women to choose this field is what keeps me motivated. This is also why I chose to write about Ida Noddack, an inspirational woman herself. Apart from science, I love to bake and feed my friends and family. I'm also an avid basketball player."

AVANI GUPTA (2PCM)

Ida Eve Noddack was a brilliant German chemist and physicist born in Lackhausen on 25th February 1896. Because she has been nominated for the Nobel Prize in Chemistry 3 times, one would think that she always wanted to be a chemist but that's not true - "Since I did not want to be a teacher at all, and research and industry employed proportionally fewer physicists at that time, I decided to become a chemist – a decision that was welcomed by my father who owned a small varnish factory in the Lower Rhine region."

She entered the Technical University of Berlin in 1915, being one of the nine students in the class of eighty-five members to study chemistry. She graduated in 1918 with a degree in chemical and metallurgical engineering. She was one of the first women to study chemistry in Germany.
After her graduation, she went on to earn a doctorate from the same university in 1921. She became a researcher at the Physico-Technical Research Agency in 1925.

In the Physico-Technical Research Agency, she collaborated with Otto Berg and her future husband Walter Noddack. The three chemists set out to discover elements 43 and 75. On bombardment of platinum and columbite ores with electrons which led to the emission of X-rays, they announced the detection of the predicted elements. Atomic number 43 was named Masurium after Walter's birthplace and atomic number 75 was named Rhenium after Ida's birthplace. Rhenium was confirmed shortly after its discovery in 1925 and the Noddacks had extracted 1 gram of rhenium from molybdenite by 1928. However, due to their inability to extract masurium, it could not be confirmed. Despite the scientific community's denial of their findings, the Noddacks held firm in their beliefs regarding masurium. Carlo Perrier, an Italian mineralogist, and Emilio Segrè, an Italian-born American physicist, produced atomic number 43 (technetium) in a cyclotron in 1937. Because technetium required a particle accelerator to manufacture, it was thought improbable that the Noddacks had found the element. Meanwhile, in her personal life, she married Walter Noddack in 1926.

The couple was nominated for the Nobel Prize in Chemistry for their discovery of rhenium and masurium. In 1931, Ida and Walter received the coveted Liebig Medal from the German Chemical Society for their achievement.

Due to the 1929 Wall Street crash, a woman's standing in the workplace had been declining for years. In 1932, a German law, similar to others around Europe, was enacted that required married women to abandon their occupations and become housewives for men to have greater opportunities.
Due to her position as an "unpaid collaborator," Noddack was able to avoid the law. Because she was only allowed to work because of this loophole, she was looked down upon by males in the field.

Enrico Fermi, an Italian scientist, stated in 1934 that bombarding uranium with neutrons might produce atomic elements heavier than uranium (or transuranium elements). However, Noddack mentioned in passing in a study - “On Element 93” - on Fermi's finding that uranium bombardment might have resulted in smaller nuclei. Her idea was the first time the concept of nuclear fission was proposed.

The significance of this study stems from Noddack's suggestion that “it is conceivable that the nucleus breaks up into several large fragments, which would, of course, be isotopes of known elements but would not be neighbors of the irradiated element.” However, because it was not backed up by unambiguous chemical data, it was dismissed at the time. German researchers Otto Hahn and Fritz Strassmann demonstrated in 1938 that uranium could divide into lighter elements and that fission was indeed possible, proving Noddack correct. Thus, her original hypothesis was finally accepted.

In 1935, Noddack joined Walter at the University of Freiburg, where she was hired as a research associate. Noddack spent the rest of her career as a researcher at institutions where Walter had been hired as a professor. The Noddacks relocated to Strasbourg University in Nazi-occupied France in 1942

When France regained control of Strasbourg in 1944, the Noddacks returned to Germany. They spent several years in Turkey after World War II ended. They returned to Germany in 1956 to work at the Bamberg State Research Institute for Geochemistry. In 1968, Noddack retired, which was followed by her demise on 24th September 1978 in Bad Neuenahr.

Figure 11.1 Ida Noddack

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Eunice Newton Foote: An Unsung Female Chemist

"I am Ally James. I relish working with chemistry and am a Hodophile. I like to travel a lot and is enthusiastic to study new places, their lifestyle, culture and food.."

ALLY JAMES (2MCHE)

Historically, science has been a male-dominated field. However, for the last several years, the number of women in the science, technology, engineering, and mathematics (STEM) fields has grown dramatically. The current number of women in STEM careers around the world is around 30 percent. Women scientists are paid less for entry-level positions and have shorter careers with fewer opportunities for advancement. Despite publishing as many papers as their male colleagues, women make up only about 25 percent of the scientific paper authors.
It's even lower in fields like math, physics, and computer science, where women make up only 15 percent of paper authors. Despite tremendous challenges, numerous women have excelled and risen to the top. Here is a lesser-known woman scientist who broke the mold, excelled, and had a lasting impact on their fields and beyond.

Often credited to British scientist John Tyndall, the greenhouse effect is one of the foundational discoveries of climate science. But Eunice Newton Foote (1819-1888), a pioneering scientist who advocated women's rights, was the first to theorize and demonstrate the greenhouse effect.

Born in 1819 as Eunice Newton, a farmer's daughter, she attended Troy Female Seminary - the only US school for girls to offer a scientific curriculum, including its chemistry lab.

A series of experiments in the 1850s involved her filling glass cylinders with different gases, placing them in the sun, and measuring the temperature changes. According to her research, the sun's rays are warmer when passing through moist air than dry air - and they are the warmest when passing through carbon dioxide. Once heated, and under different moisture conditions, she placed both cylinders in the sunlight to measure the temperature variance once they reached the same temperature. This experiment was conducted on CO2, common air, and hydrogen. According to Foote, carbon dioxide (CO2) trapped the most heat, reaching a temperature of 125°F (52°C). During this experiment, she stated, "The receiver containing this gas became much hotter than the other- and on being removed from the Sun, the cooling time was much longer."

In 1856, Foote presented her paper at the 10th annual meeting of the American Association for the Advancement of Science (AAAS) in Albany, New York. Nevertheless, she was the only woman to present a paper in the first decade of annual AAAS meetings.

Because women were not permitted to present their work, her paper was read by Joseph Henry, the first secretary of the Smithsonian Institution and an advocate for women scientists.

Scientific American magazine, in a piece on the 13 September issue, praised the results of Mrs. Foote's experiments with condensed gases, saying that the article demonstrated that the ability of women to explore any subject with originality and determination was abundantly demonstrated by the experiments of Mrs. Foote.

In the AAAS proceedings from August 1857, she published a second paper titled, "On a new source of electrical excitation." She discussed experiments using gas-filled tubes attached to a gold leaf electrometer to detect electric charges.

Variations in atmospheric pressure and temperature were blamed for the impacts of shifting pressure, temperature, and humidity. For her article, she was even dubbed "America's Faraday," which received a lot of attention.

By 1860, she had submitted many patents, one of which was for improved papermaking. She devised a thermostatically controlled cooking burner in 1842, but she had to patent it in her husband's name because married women were not allowed to oppose patents in court.
After her early scientific triumphs, she doesn't appear to have published any more experimental data. She was, nevertheless, well-known for her contributions to the American women's suffrage and abolitionist campaigns.

She signed the 'statement of sentiments,' a manifesto for women's equality, at the first US women's rights convention in Seneca Falls, in 1848. Foote was one of five women who contributed to the conference proceedings.

After discovering Foote's work, it's important to consider whether Tyndall, who worked at the Royal Institution in London and published his research in 1859 and 1861, was aware of it when he published his findings, which are widely credited with establishing our current understanding of the greenhouse effect. People have just begun to accept Mrs. Foote's findings and to identify her as the scientist who first demonstrated and worked on the greenhouse effect.

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· A. Zissu, Earth squad.

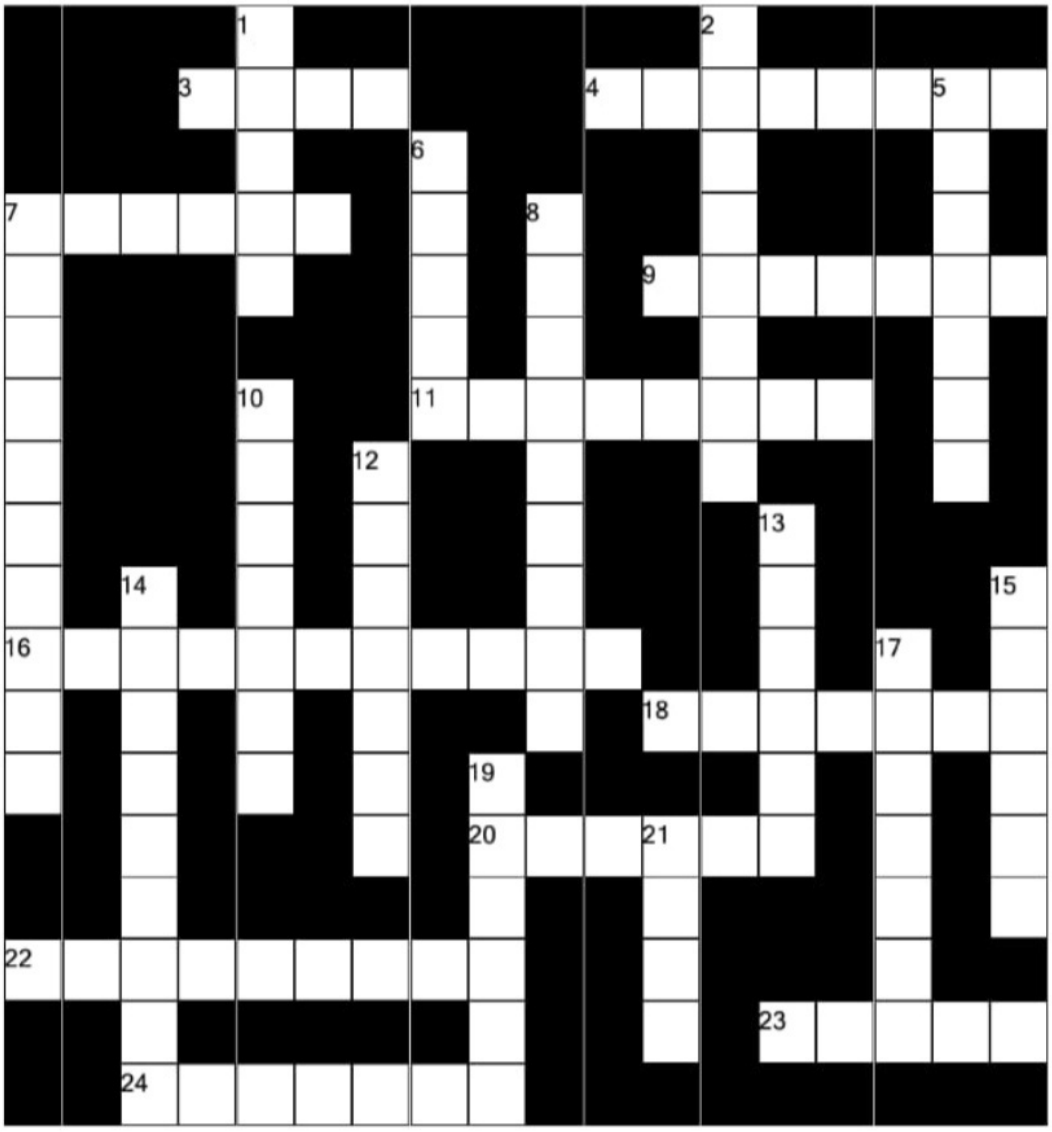
Crossword

"I am Abymol Abraham, a first year MSc student. I am interested in material science research field.Apart from academics I like creative art and craft. I do handmade cards as a passion and business. Listening to music is my favourite hobby."

ABYMOL ABRAHAM (2MCHE)

Across
3. transition element found in breakfast,cereals and hjman blood
4. my address is group 6 period 4
7. horizontal row
9. Im the only element in halide family as liquid
11. I'm transition metal with 78 electrons
16. Rg
18. element which means stone in greek
20. I'm a gas of 8 protons and 8 neutrons
22. four element theory
23. Im a noble gas in period 5
24. quicksilver

Down
1. for my discovery in 1895 Lord Rayleigh won nobel prize on 1904
2. im the lightest of halogen
5. heaviest naturally occuring element
6. vertical column
7. I have 5 valence electron and 3 energy levels
8. kalium
10. superman's home
12. heaviest metalloid in period 4
13. another word for atomic mass unit



Quizlet

"I am pursuing my final year post graduation in General chemistry at CHRIST (Deemed to be University) Bangalore. I have my own ideas to do in future with respect to carrier it might be in starting up industry or some labs. This was all about what I want to achieve. My hobbies include Photography, cooking, anime, gardening, looking through some science fiction movies and various other things. My interest is more on practical aspects rather than theory. Two quotes that always guide 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."

KARTHIK N (4MCHE)

1. I'm in the marshes. Also found in cattle rumen. To Stop global warming I do very little what am I?
2. Name the element that was created artificially.
3. DNA codes proteins, which are the constituent elements of organisms. What is the most abundant protein in the body?
4. Mars is called the red planet because it resembles which rusty metal?
5. I apply to each species an ideal solution under all conditions of temperature, pressure, and composition. I relax showing that the escape potential of each species in an ideal solution is proportional to their molar fraction.
6. I am a type of hydrocarbon in which all molecules contain a benzene ring structure and the products are incompletely burned and appear in burnt toast and grilled meat and in-car fumes. Guess what kind of hydrocarbon I am?
7. You call me a metal but I flow like a liquid even though I can kill you, you will keep me around I am not as dense as gold yet my shine is like silver I will always be up when you are feeling down What am I?

8. I am an element that dead or grave diggers have to deal with. What am I.?
9. Bright as silver, denser than a lead, more expensive than gold, could stop a bullet if I wanted who I am?
10. The world of chemical reactions is like a stage the actors on it are the elements. Name the scientist who quoted the above sentence and Name the element he discovered?

ANSWERS

1.Methane gas
2.Technitium
3.Collagen
4.Iron
5.Lewis Randall Rule
6.Polycyclic Hydrocarbon
7.Mercury
8.Barium
9.Osmium
10.Clemens Alexander Winkler (Element – Germanium)

Turning Endless Plastic Waste to Endless Energy

"As I read science books, I come up with more questions than solutions and that is what keeps me interested in it. My name is Rukma and I am a first-year UG student of BSc BCB Christ (Deemed to be University). I love chemistry and would want to get into the field of research. Apart from academics, I love to fangirl over k-pop and k-drama idols. My article covers the possibilities of plastic to fuel transformation. A major impact of plastic bags on the environment is that it takes about 450-500 years to decompose. In addition, a large number of toxic substances are released into the soil when they perish under sunlight. If burned, they release several carcinogenic compounds into the atmosphere causing ambient air pollution."

RUKMA S KUMAR (2BCB)

To go by the famous quote, “Waste Isn’t a Waste until We Waste It as Recycling Turns Things into Other Things like Magic”. Every year, we create 683 million tons of plastic waste worldwide. This not only fills up landfills but wastes energy and also causes extensive damage to the environment and wildlife.

Some researchers have found that less than 5% of manufactured plastic is recycled each year. This plastic permeates our oceans and they say that it would take more than 450 years to biodegrade if it ever did. The facilities that partake in plastic-to-fuel transformation not only help in the recovery of exhaustible natural resources such as resin and other rare metals but also have the potential to bring about 39,000 new jobs and almost $9 billion in economic output. This would not only improve our economy but also provide new ways to reuse plastic and save our environment.

How plastic to energy works

Plastic is made out of refined crude oil. Its price and production are dictated by the petrochemical industry. Oil is a finite natural resource so the most sustainable option would be to reduce crude-oil consumption by recycling the waste plastic materials and recovering the raw material as much as possible.

Figure 15.1 Recyclying of plastics into energy

Plastics

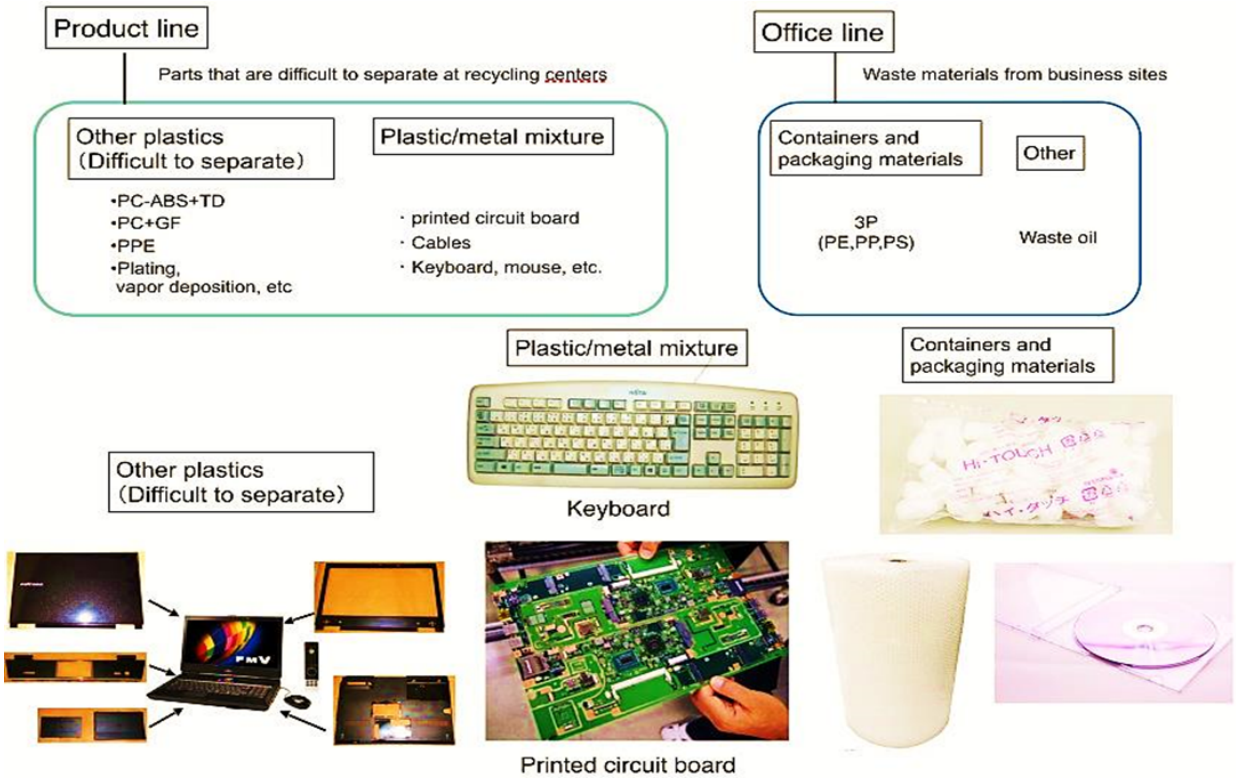


Figure 15.2 different forms of Plastics

Different Techniques of Conversion

Pyrolysis

This requires heating the plastics materials (such as density polyethylene bags) at a very high temperature (300-900 degrees Celsius) in the absence of oxygen. This in turn produces oil that is similar to crude oil [plastic crude oil (PCO)]

Using energy-efficient, low-emissions pyrolysis, we can convert non-recyclable plastics into highly profitable fuel and chemical products.

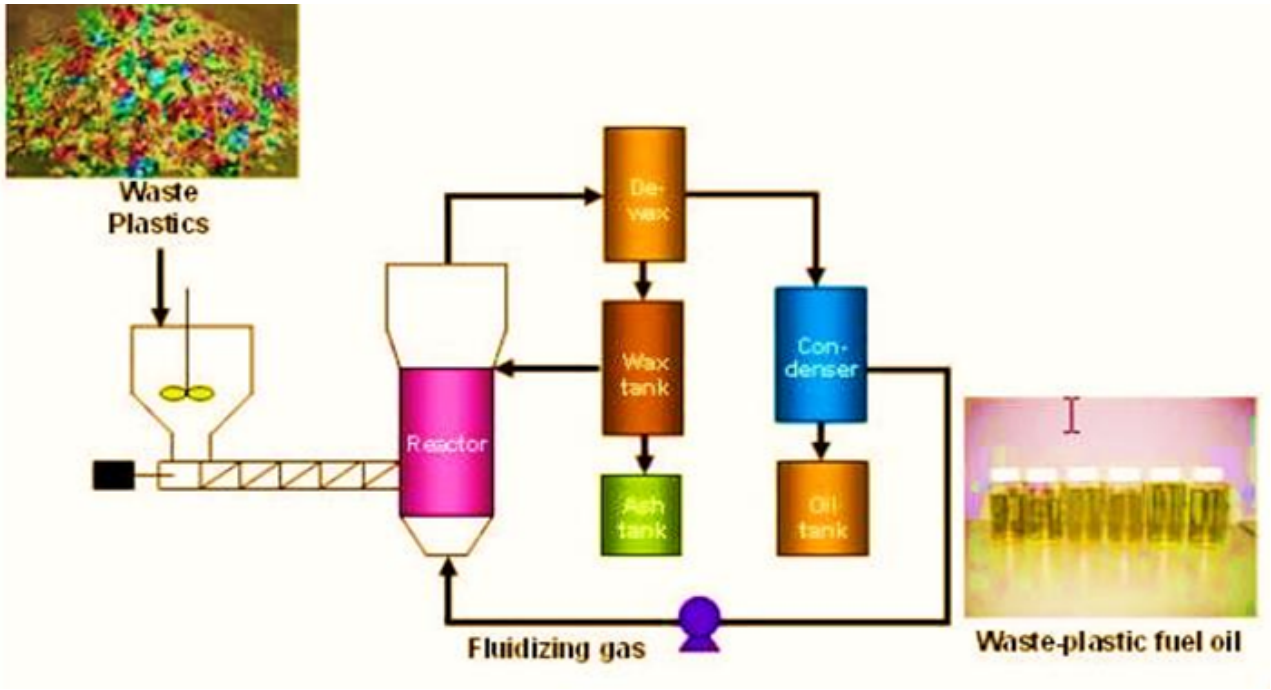


Figure 15.3 Recycling of waste plastic to fuel oils

Gasification

This involves heating the waste plastic with air or steam, to produce a valuable industrial gas mixture called the "syngas" or "synthesis gas (CO + H2)". This can then be used to produce diesel and petrol or could be burned directly in boilers to generate electricity.

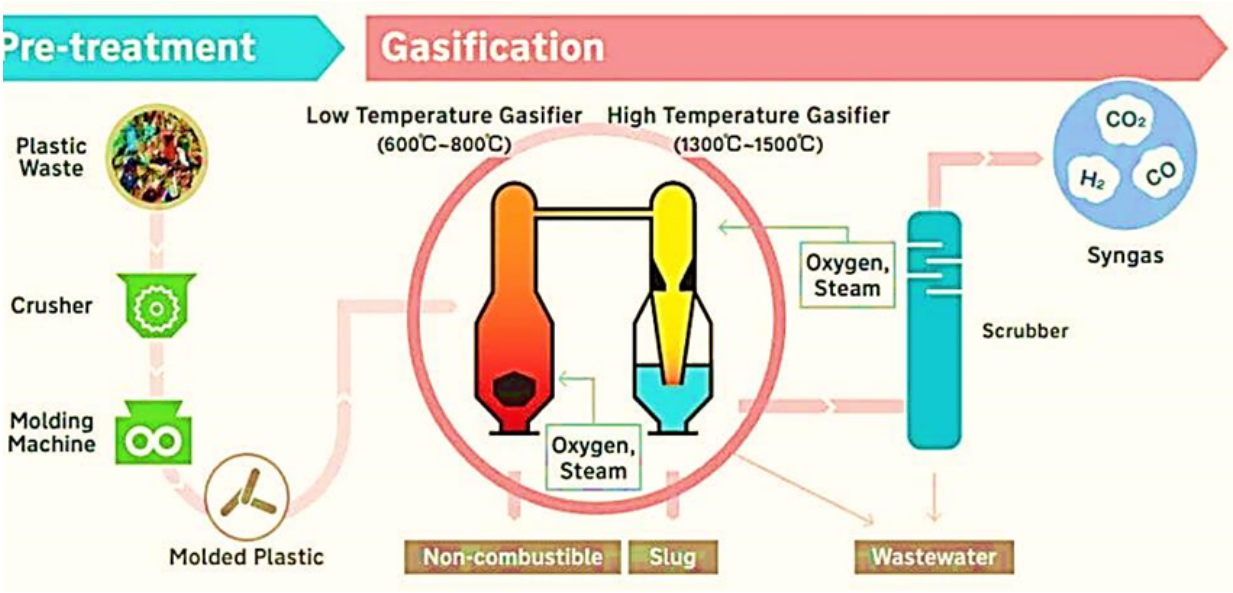


Figure 15.4 Pre treatment and Gasification of plastic waste

Gasification and Pyrolysis are different from each other which involve incinerating the plastic. The main goal is simply to destroy the waste, thus keeping it out of the landfill. The heat released from incineration could also be used to produce steam to drive a turbine and generate electricity.

Liquefaction

This entails the creation of reusable oil from plastic waste that isn't always recycled or recyclable. These include difficult-to-separate plastics, such as laptops, as well as plastics containing metal elements, such as computer cables, keyboards, and mice, and non-recyclable packaging materials.

This method may effectively extract resin from garbage and recover rare metals that would otherwise be burnt. Convection management is used to reduce the temperature difference between the molten plastic's bottom and the liquid surface. As a result, the effective vaporisation area is reduced, which compensates for the energy loss. Switching from incineration to recycling reduces CO2 emissions and other environmental problems, which is one of the environmental benefits of liquefaction.

Hydrothermal Processing.

This process uses polypropylene in a reactor filled with water and is heated to extremely high temperatures (from 380-500 degrees Celsius) for up to five hours at high pressure. At this high heat and pressure, plastic is broken down by the water and is converted to oil [Plastic Crude Oil (PCO)]. Most of the non-recyclable plastics are made from oil so this process brings them back to their original form.

Photo reforming -

A light-absorbing photocatalyst (such as Au, Ag, ZnO, TiO2) is added to plastic products in an alkaline solution. When exposed to sunlight, the plastic is broken down to give bubbles of hydrogen gas. This hydrogen can be used in fuel cells to power automobiles and to support the electric grid. Hydrogen is highly efficient, economical, and environmentally friendly.

Advantages

Advantages of converting plastic waste into fuel include:

- Low cost
- These plants convert either hard-to-recycle or non-recyclable plastic waste to fuel are producing fuels from combustible materials. This not only prevents those materials from ending up in a landfill but also protect environment and wildlife.
- Suitable alternatives to fossil fuels.
- Burns with lower carbon footprint than fossil fuels

- Has a higher calorific value than the starting plastic and burns more efficiently
- Highly efficient, economical and environmentally friendly.
- Plastic-to-fuel can displace the production of fossil fuels and result in lowering the emissions of net greenhouse gas (almost 15% reduction)
- Produces 60% less GHG (Green House Gas) emissions compared to fossil fuel extraction and refining.

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Single-Use Plastic - A Bane to our Ecosystem

"I am Chaithrashree K, currently pursuing a Master's degree in Chemistry. Science has always been a field that intrigued me, inspired me and motivated me throughout my academic career. Science is the key to unveil almost all and every intricate detail of nature and its components, particularly Chemistry plays a huge role in doing so. Being a chemist is a matter of great pride since we get to understand the details of a system at a molecular level and explore the infinite possibilities of dealing with an issue with a Chemistry based approach."

CHAITRASHREE K (2MCHE)

One wouldn't put much thought into using a straw to drink their favorite slushy or use a plastic spoon to dig into their favorite pastry as they assume that the waste that they generate is insignificant. But this one straw or one plastic spoon or the empty packet of chips are the ones that are posing a serious threat to the ecosystem and its sustainability.

What are Single-Use Plastics (SUPs)?

Single-use plastics, often known as disposable plastics, are only used once and then discarded or recycled. Plastic bags, straws, coffee stirrers, cups, cutlery, grocery bags, containers, and water bottles, as well as the majority of food packaging items, are examples of these goods.

Fig 16.1 Plastic waste

Why are Single-Use Plastics bad for the environment?

- Every year, we manufacture over 300 million tonnes of plastic, half of which is discarded! Only about 10% to 13% of plastic objects are recycled over the world. Because of the nature of petroleum-based disposable plastic, recycling it is challenging, and new virgin materials and chemicals must be added to the mix. Furthermore, recycled plastic can only be used in a restricted number of applications.
- Petroleum-based plastic is not biodegradable, and it usually ends up in a landfill or in the water, where it eventually ends up in the ocean and deteriorates the marine ecosystem.
- Plastic will disintegrate (break down) into microscopic particles over time, even if it does not biodegrade (decompose into a natural substance like soil). Toxic chemicals (additives used to form and harden the plastic) are released throughout the breakdown process and end up in our food and water supplies

Influence of COVID 19 over Single-Use Plastics.

According to a report published in 2021 by the Australian-based Minderoo Foundation, China is the world's greatest producer of single-use plastic, followed by the United States and India. However, although India produces 5.58 metric tonnes of single-use plastic per year, China produces six times as much, at 25.36 metric tonnes, and the United States produces 17.19 metric tonnes. Only 9% of the 6.3 billion tonnes of plastic manufactured since its inception in the 1930s has been recycled, according to the report. However, with Covid-19, single-use plastic has made a strong comeback in the country.

The prolonged lockdown has helped the environment by reducing pollution levels, but the increased usage of masks, gloves, face shields, PPE kits, sanitizer bottles, and other protective gear to combat the pandemic has raised new worries. According to China's Ministry of Ecology and Environment, hospitals in Wuhan produced more than 240 tonnes of waste every day during the outbreak, compared to 40 tonnes during the previous year.

According to these figures, consultancy firm Frost & Sullivan estimates that Covid-19 may generate a full year's worth of medical waste in just two months. According to data from the Union ministry of environment, forest, and climate change, India created 56,898 tonnes of Covid-19 bio-medical waste between June 2020 and June 2021.

Steps taken by the Indian government to tackle the issue

Prime Minister Narendra Modi had called to residents on Indian Independence Day in 2019 to make the country free of single-use plastics (SUP) and to strive tirelessly toward this goal. He asked technocrats to develop better solutions for plastic reuse and recycling, stores to stop handing out carry bags, and individuals to become more aware. In December 2020, the agenda of making the country SUP-free was covered in the monthly "Mann ki Baat."

The Union Ministry of Environment, Forest, and Climate Change notified the Plastic Waste Management Amendment Rules, 2021, on August 12, 2021, banning 20 single-use plastic goods like earbuds, plastic sticks, balloons, plastic flags, candy sticks, polystyrene (thermocol), plastic plates, cups, glasses, and other cutlery by 2022, by the announcement.

Latest Research to find an alternative to Single-use plastic

- Researchers at the Indian Institute of Science, Bengaluru from the Department of Material Engineering have discovered a means to make a single-use plastic substitute that, in theory, can help mitigate the problem of accumulating plastic garbage in the environment.
- The Researches have synthesized polymers containing non-edible oil and cellulose derived from agricultural stubble. These polymers can be molded into sheets that can be used to make bags, flatware, or containers. The result is a biodegradable, waterproof, and non-toxic substance.

- Non-edible Castor oil was employed in the polymerization process, which included allowing them to react with cellulose and a di-isocyanate molecule. All of the precursors are combined in toluene solvent and heated for 8 hours at 80°C. The toluene was then evaporated by pouring the solution mixture into a Teflon sheet. Because of the crosslink between the functional groups present in the precursors, a beautiful polyurethane film was generated after 12 hours.
- The sheets of polymer that were created were put through a leaching test as well as a thermal stability test, and they passed both. These preliminary findings indicate that the material is suitable for use in food packaging.
- More experiments are being carried out to establish the sheet as though it were food-grade. To generate sheets with qualities such as flexibility, which are useful for a variety of applications, The researchers experimented with the ratios of cellulose to non-edible oil in their articles.

- The stiffer the material became with more cellulose and less non-edible oil, the better it was for creating tumblers and cutlery. The higher the oil content, the more flexible the material was and the easier it was to form into sheets for producing bags.
- A provisional patent has already been submitted by the organization.
- They plan to use the material for healthcare applications as well because it is biodegradable and non-toxic. Given the rise in the use of single-use plastics and the challenge of managing landfills choked with SUPs, such alternatives could bring a paradigm shift, especially in the packaging sector, which is the largest consumer of SUPs.

Simple methods that can be followed to cut back on single-use plastics

It is easier said than done. But a little change in our lifestyle could make a huge impact on reducing plastic waste. Some methods to cut down plastic usage in our daily lives are listed below:

- Always carry reusable shopping bags when you are shopping.
- Avoid bottled water and switch to using BPA-free reusable water bottles.
- Say no to plastic straws, use metal straws or paper straws instead which are better alternatives to the plastic straw. If using straws is completely avoided, that's even better.
- Shopping at a farmers market not only gives you access to fresher produce and commodities, but it's also better for the environment because the food is normally grown locally, takes less transportation, and isn't usually wrapped in plastic like much of the groceries available in supermarkets.
- Switching from liquid body wash and shampoo, which are often packaged in plastic bottles, to bar soaps and shampoos will help reduce your personal use of plastic and your environmental effect.

- Around the world, almost 500 billion single-use coffee cups are thrown each year. These cups come in a variety of sizes, from full plastic cups to paper cups with a plastic liner and lids. Many of these cups end up in landfills, where they take years to degrade. Bring a reusable cup or mug to your favourite coffee shop to help contribute to the solution.
- Many of the foods that are discarded may be recycled or composted, which would save landfill space. Composting food waste saves time and money while also improving soil quality.
- Stop smoking, or at the very least switch to a lighter that can be refilled. Despite their insignificance, cigarette filters are composed of plastic and contribute greatly to pollution.
- Make the transition to chewing gum that isn't made of plastic. Chewing gum is packaged in a lot of plastic, which adds to 100,000 tonnes of pollution every year. Fortunately, several companies produce plastic-free gum, so you don't have to completely abandon your habit.

- Clothing is the primary source of microplastic contamination. Polyester, nylon, acrylic, and other synthetic fibres are all types of plastic that may be found in about 60% of today's clothing. As a result, simply washing a load of laundry can release thousands of microscopic plastic fibres into the water system, eventually ending up in the ocean. Despite the fact that the vast majority of textiles are recyclable, 85 percent of used apparel ends up in landfills. Plastic bags, like synthetic clothes, can take hundreds of years to decompose. Buying old clothing is one of the most environmentally friendly ways to shop because it keeps plastic out of landfills and does not require new energy to produce.

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