

CHEM

<p>9 F Fluorine</p>	<p>8 O Oxygen</p>	<p>29 Cu Copper</p>	<p>16 S Sulfur</p>
------------------------------------	----------------------------------	------------------------------------	-----------------------------------

A Chemistry Magazine

2024-25

DEPARTMENT OF CHEMISTRY
ST. JOSEPH'S COLLEGE,
MOOLAMATTOM

FROM PRINCIPAL'S DESK



Best wishes for the success of Chem Focus

It is with immense joy and profound pride that I offer my sincere congratulations to the Postgraduate and Research Department of Chemistry at St. Joseph's College, Moolamattom, on the launch of their magazine, Chem Focus. This outstanding initiative embodies the department's unwavering dedication to promoting excellence in education, research, and scientific communication.

In the rapidly evolving academic landscape of today, it is crucial for students and researchers to not only thrive in their individual disciplines but also to actively participate in the sharing of ideas, innovations, and discoveries. Chem Focus acts as a significant platform to highlight the lively and dynamic work occurring within our department, showcasing the accomplishments, research efforts, and contributions of our students and faculty. It will offer a distinctive opportunity to disseminate knowledge, insights, and the latest trends in the field of chemistry. I urge all department members to keep fostering this tradition of innovation and excellence. May Chem Focus emerge as a symbol of the intellectual curiosity and research-driven outlook that we aspire to cultivate in our students. I am certain that this magazine will inspire and motivate many, aiding in the continued advancement of science and chemistry as a discipline.

Once again, my heartfelt congratulations to the entire team behind Chem Focus. I wish you all ongoing success in this undertaking, and may this magazine expand in both depth and influence in the years ahead.

Best regards,

THOMAS
GEORGE

Digitally signed by
THOMAS GEORGE
Date: 2024.12.10
15:45:34 +05'30'

Prof. Dr. Thomas George CMI, Principal

MESSAGE FROM THE HEAD OF THE DEPARTMENT



On behalf of the Chemistry Department, I am delighted to extend my heartfelt congratulations on the successful publication of our departmental magazine. It brings me great pride to see the collaborative efforts of our talented faculty and enthusiastic students come to fruition in this vibrant publication.

To our incredible student editors – Preteena P Varghese, Aleena Joy, and Aflah P – you are the heartbeat of this publication. Your remarkable dedication has transformed academic insights into a vibrant, engaging narrative that brings chemistry to life. Each page reflects your incredible ability to blend scientific precision with creative storytelling.

And our guiding light, Dr. Anu Antony, our Faculty Editor – your mentorship is the secret ingredient that elevates this magazine from good to extraordinary. Your expert guidance has nurtured these young talents, helping them transform complex scientific concepts into compelling content.

Behind every article, every graphic, every carefully crafted word, there are countless hours of research, brainstorming, and collaborative spirit. This magazine is a celebration of our department's commitment to excellence, innovation, and the pure joy of scientific discovery.

I extend my best wishes to the entire editorial team and look forward to future editions that continue to inspire and enlighten our academic community.

Warm regards,

Dr. Sr. Sijo Francis
Head of the Department
Department of Chemistry

EDITOR'S DESK

“The meeting of two personalities is like the contact of two chemical substances: if there is any reaction, both are transformed.”

Carl Jung



It is an absolute pride and delight for all of us since the Postgraduate and Research Department of Chemistry is launching a magazine in chemistry named “ChemFocus” in the year 2024. The notion of designing and launching this magazine commences with the efforts of the Head of the Department, members of the editorial board, faculties of the Department and students. .

"ChemFocus" serves as an outstanding platform to showcase the synergy between chemistry and its advancements through artistic illustrations, insightful knowledge, and more. Few sections are drafted to manifest the experiences of the teachers beautifully.

First and foremost I would like to thank our Principal for his encouragement and unwavering support. I extend my heartfelt gratitude to our esteemed Head of the Department for her support and invaluable guidance in conceptualizing and launching this magazine. I express my heartfelt appreciation to all student authors and faculty members of the department for their contribution to this magazine. I also acknowledge the efforts taken by dedicated students in the editorial board in enhancing the perfection and beautification of the magazine. I hope this magazine would provide you reading pleasure and enhance your knowledge in the field of chemistry.

Dr. Anu Antony
Assistant Professor

STUDENT EDITOR'S NOTE



Welcome to this exciting issue of ChemFocus! As we continue to explore the ever-evolving landscape of chemical science, we are pleased to present a collection of cutting-edge research, insightful reviews, and thought-provoking articles. This magazine covers a wide range of topics, from sustainable energy solutions and green chemistry innovations to the latest breakthroughs in nanotechnology and biochemistry.

We are particularly excited to feature a special section on the role of chemistry in tackling climate change, highlighting the critical contributions scientists are making to develop more sustainable processes and materials. This magazine also marks the beginning of a new attempt, where we explore how the molecular world impacts the products and technologies we use daily.

We hope this magazine would inspire you to continue pushing the boundaries of scientific discovery and to stay curious about the world around you. Whether you're a researcher, educator, or simply a chemistry enthusiast, there is something for everyone to enjoy and learn from.

We would also like to thank our teachers for their guidance at every stage which helped us to give a final shape to the magazine. We had a great experience and we hope you would enjoy reading the articles and the creativity in them.

Sincerely,

Prettina P Varghese

Aleena Joy

Aflah P

About Post Graduate and Research Department of Chemistry

The Postgraduate and Research Department of Chemistry is the oldest department at St. Joseph's College, Moolamattom and has a history of long 42 years in offering rigorous, engaging, and meaningful training in the field of Chemical Science to our students. With its inception in



1982 with Pre-degree course, the Department of Chemistry became a full-fledged undergraduate department in 1991. The Department was elevated to a postgraduate department in 1999 and subsequently to a research department in 2005. The Department also received national recognition when it was selected for FIST programme by the Department of Science and Technology, Government of India in 2012. A DST-FIST supported instrumentation centre was set up in the department in the year 2014 and a well-equipped Laboratory and an Instrumentation room were added to the infrastructure. The invaluable contributions of former HODs and pioneers of the Department, Sri. Thomas Sebastian, Rev. Dr. C. J. Paul CMI, Late Dr. Siby Joseph, Dr. Saju M Sebastian, Dr. K. C. Joseph, Dr. Ebey P. Koshy and Dr. George V. Thomas in nurturing and upbringing the department to its present stature are unforgettable. Rev. Dr. C. J. Paul CMI, Dr. George V. Thomas, Dr. Saju M Sebastian, and Dr. Ebey P. Koshy had served the college as Principals. Our Department is one of the leading centres for Research in Chemical Sciences in M.G. University, Kottayam, Kerala. Out of the five faculty members four are Ph.D holders and two are research guides under Mahatma Gandhi University. One faculty is a post-doctoral fellow. The department has also produced many rank holders and CSIR-UGC/GATE winners. So far, the department has produced five Ph.Ds. The Department constantly strives to impart quality education and moral values to its students, transforming them to better citizens of tomorrow. The quality of the Department is reflected through frequent university ranks, descent number of JRF and GATE qualifiers and ample number of research publication in UGC-CARE listed journals.

1	Important milestones in the discovery of periodic table	1
2	Tinted Science: Delving into the Chemistry of Dyes and Pigments	3
3	Tracing the Path from 'Silent Spring' to the Birth of Green Chemistry	5
4	The significance of Cesium in modern time keeping	7
5	Marie Curie	9
6	Life from stardust	11
7	From red to blue: Significance of color in fruits and vegetables	14
8	Wonders of chemistry around Us in nature	16
9	Chemical disasters	19
10	Inspirations and facts behind Nobel Prizes	21
11	Chemistry behind the emotion “Happiness”	24
12	Unveiling pharmaceutical chemistry	27
13	Carbon: Backbone of Organic Chemistry	29
14	Catalysts: Enhancing daily life processes	31
15	Clean water through nanotechnology: An insight into Dr. T. Pradeep’s research	33
16	Beauty meets chemistry	36
17	The Science behind flavour and aroma	38
18	The science behind culinary innovation- Molecular gastronomy	40

CONTENTS

CONTENTS

Sl. No	Title	Page No.
19	The anomalous expansion of water	43
20	Influence of Artificial Intelligence on scientific research	45
21	Why are we celebrating National Science Day	49
22	Chemical waste management	51
23	The future of bioplastic: A sustainable alternative	53
24	The alchemy of fragrance: Crafting scents through science	56
25	Career Path for Chemistry Graduates in Our Country	59
26	Life without chemistry: An impossible concept	61
27	Chemistry of art preservation	63
28	Nanochemistry: Pioneering the Future of Medicine	65
29	Pioneering design and material discovery	67
30	Under the ozone's embrace	70
31	Various classification of chemistry	71
32	Astounding facts in chemistry	73

IMPORTANT MILESTONES IN THE DISCOVERY OF PERIODIC TABLE

1

1789
Antoine Lavoisier



French chemist **Antoine Lavoisier** in 1789 grouped the 33 known elements into categories based on their properties, including gases, metals, non-metals, and earths.

2

1817
Dobereiner – Triad



In 1817 German physicist **Johann Wolfgang Dobereiner** observed similarities in the physical and chemical properties of few elements. He classified elements in the increasing order of their atomic mass into three groups called Triads. In each Triads the atomic mass of the middle element was approximately equal to the average atomic mass of the other two elements and the defect was that he could not arrange all the known elements at that time into Triads.

3

1864
John Newlands - Octaves



British chemist **John Newlands** in 1864 was the first to arrange elements into the periodic table in the increasing order of their atomic masses, into groups of eight elements called Octaves without leaving no gaps for undiscovered elements.

1789
Dmitri Mendeleev

4

Russian Chemist **Dmitri Mendeleev** in 1869 created a framework that later became the modern periodic table, leaving gaps for the elements yet to be discovered. He classified elements on the basis of increasing order of their atomic mass. It consisted of 6 horizontal rows called Periods and 8 Vertical columns called Groups. But the defect noticed was the grouping of chemically dissimilar elements, separation of chemically similar elements and no position for isotopes.



1870
Lothar Meyer

5

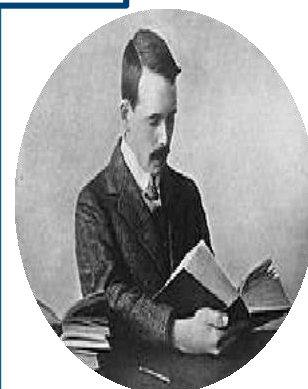
In 1870 German chemist **Lothar Meyer** developed a version of the periodic table which was similar to Mendeleev's. He didn't predict the properties but left gaps for undiscovered elements.



1913
Henry Moseley

6

Finally, English physicist **Henry Moseley** in 1913 arranged elements according to their atomic numbers. Modern periodic table was based on Modern Periodic law. It states that "the physical and chemical properties of the elements are periodic functions of their atomic number". Modern Periodic Table is also known as long form of the periodic table. It consists of 7 Horizontal rows (Periods) & 18 Vertical columns (Groups). Total of 118 elements are there in the modern periodic table.



VON MAHESH

Ist B.Sc (Hons.) Chemistry



TINTED SCIENCE: DELVING INTO THE CHEMISTRY OF DYES & PIGMENTS

DYES

Dyes and pigments are colorants used in various industries, including textiles, food colouring, cosmetics, and scientific research. They differ in their chemical properties, interaction with substrates, and mode of application. Dyes are organic molecules that attach to a substrate through chemical bonds or physical adsorption, allowing them to colour it uniformly. They are typically used in textile, leather, and paper industries.

PIGMENTS

Pigments, on the other hand, are either organic or inorganic compounds that provide colour through scattering or absorption of light. They are mixed with a binder to form a stable suspension, which adheres to a surface. Pigments are often characterized by complex inorganic structures, such as

metal oxides, sulphides, and silicates. Examples include anthraquinone dyes, azo dyes (containing $-N=N-$ linkages), and phthalocyanine dyes.

CLASSIFICATIONS

Dyes and pigments are classified based on their chemical structure, method of application, and type of interaction with substrates. **Acid dyes** contain acidic groups, which are applied to fibres like wool, silk, and nylon, producing vibrant colours. **Basic dyes** contain basic groups, used for colouring paper and acrylic fibers. **Direct dyes** are applied directly to cotton and cellulose fibers without the need for a mordant, having a high affinity for cellulose. **Reactive dyes** form covalent bonds with fibers like cotton, wool, and silk, are highly wash-fast, and are commonly used in the textile industry. **Disperse dyes** are non-ionic dyes used for synthetic fibers

like polyester, applied as a fine dispersion in water.

Vat dyes are insoluble in water and require a reduction process to become soluble (leuco form), after which they are absorbed by the fiber and then oxidized to form an insoluble coloured compound. Understanding the chemistry behind these substances provides insight into their behaviour, stability, and functionality in various industries.

Pigments are classified into organic and inorganic categories each with distinct characteristics. **Inorganic pigments**, derived from minerals and metal compounds, offer opacity, durability and resistance to chemical and environmental conditions. **Organic pigments**, based on carbon structures, offer brighter and more vibrant colours but may be less stable under extreme conditions.

The synthesis of dyes and pigments involves complex organic and inorganic chemistry. Most synthetic dyes are produced through organic reactions, such as diazotization and coupling of anilines or condensation reactions. Azo dyes are synthesized through a reaction between a diazonium salt and a

coupling component like phenol or aniline, while reactive dyes require the incorporation of a reactive group like triazine. Pigment syntheses involve processes like calcination, precipitation, and oxidation.

Dyes and pigments have unique properties that make them indispensable across various industries. They are used in textiles to colour fibers, printing inks, plastics, cosmetics, food and pharmaceuticals. However, the use of synthetic dyes and pigments raises environmental and health concerns. Many synthetic dyes and pigments contain heavy metals, aromatic amines, and other hazardous chemicals that can be toxic and carcinogenic.

Environmental impact is a major concern, as dye effluents from textile industries are a major source of water pollution. Conventional dyes are often non-biodegradable and can cause severe harm to aquatic life. Certain inorganic pigments, such as cadmium and lead-based pigments are toxic and bio-accumulative. Prolonged exposure to certain synthetic dyes and pigments can cause allergic reactions, respiratory problems, and cancer.

Devika Biju

IInd MSc. Chemistry

“We stand now where two roads diverge. But unlike the roads in Robert Frost’s familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road — the one less travelled by — offers our last, our only chance to reach a destination that assures the preservation of the earth.”

— Rachel Carson, *Silent Spring*

TRACING THE PATH FROM ‘SILENT SPRING’ TO THE BIRTH OF “GREEN CHEMISTRY”



In 1962, an American conservationist and writer named Rachel Carson wrote a book named “Silent Spring”. In her book she mentioned about the havoc that certain pesticides and chemicals laid on human health and environment. Although the book faced strong opposition from chemical

companies, this book could gather worldwide attention on how certain chemicals and pesticides affect the biosphere and marked the beginning of a green revolution in chemistry. The author also highlighted the unintended hazards of pesticides on our eco system and human health based on different scientific reports and materials, and demanded strict environmental regulations to control and limit the widespread use of such harmful chemicals. This book was a warning to the public and also inspired scientists. Motivated by this, the American Congress passed the National Environmental Policy Act

(NEPA) in 1969 with the objective to “create and maintain conditions under which man and nature can exist in productive harmony”. In 1970, the U. S. Environmental Protection Agency (EPA) was established by President Richard Nixon for the protection of environment and human health. EPA, as an initial measure, in 1972, banned the domestic use of the pesticide DDT due to its widespread misuse and the negative impact it placed on our earth. In 1987, the Montreal Protocol was established by the United Nations - the first treaty in the history to get universal approval; aimed at reducing

the production and consumption of ozone depleting substances. In 1990’s, scientists began to recognize that pollution prevention requires much more attention than pollution control and accordingly, the Pollution Prevention Act came into effect. For the first time, the phrase “green chemistry” was coined by the staff of the EPA Office of Pollution Prevention and Toxins and by late 1990’s, green chemistry and its twelve principles were defined by Paul T. Anastas and John C. Warner in their book Green chemistry: Theory and Practice.

Dr. Anu Antony
Assistant Professor

THE SIGNIFICANCE OF CESIUM IN MODERN TIME KEEPING

Cesium is an element that is crucial in defining the base unit of time in International System of Units (SI), the second. Atomic clock uses cesium -133 which operates based on the vibration of cesium atoms. These atoms when exposed to microwave radiation, they oscillate at a specific frequency which is very stable. This stability allows atomic clock to measure the time with incredible precision. Specifically, the clock measures the oscillations of these atoms, which occur at a very precise frequency of 9,192,631,770. The time in atomic clock deviate only about one second in every 30 million years

THE ROLE OF CESIUM IN TIME KEEPING

Watches, once a simple time telling device has evolved to sophisticated instruments which embody precision, craftsmanship and advanced technology. Cesium watches can be regarded as one of the most remarkable achievements in time keeping. Cesium watches utilises properties of cesium to achieve unprecedented accuracy.

Cesium watches incorporate atoms while traditional watches still rely on



mechanical movements or quartz technology. Cesium timepieces include a cesium oscillator which will ensure incredulous accuracy. The design of cesium clock integrates advanced electronics and sophisticated engineering which allows the watch to synchronise with the standard time signals emitted by atomic clocks around the world due to this technology. Cesium watches maintain accuracy that far surpasses conventional watches.

THE FEATURE OF CESIUM WATCHES

Due to technological advances, cesium watches are likely to become more accessible to consumers. Ideas and innovation in the technology, miniaturisation, and electronics can lead to more compact and proper designs in future without compromising accuracy. In addition, the incorporation of cesium technology into smart watches could provide consumers with connectivity as well as atomic level timekeeping.

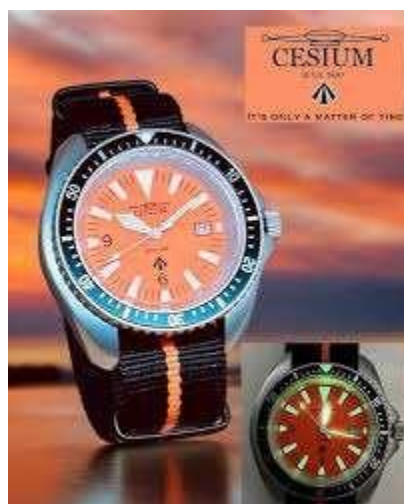
The ability of cesium watches to provide incomparable accuracy has various applications across various fields, from telecommunications to aviation and beyond. They truly represent an astonishing intersection of science, technology and craftsmanship. As the demand for accurate timekeeping continues to escalate, cesium watches in future will play an extraordinary role in our daily lives redefining what it means to be “on time” in an ever connected world.

IMPACT ON VARIOUS FIELDS

The entanglement of cesium watches extend beyond personal timekeeping. Precise and accurate time

synchronisation is necessary for data transmission and network operations in the arena of telecommunication.

GPS technology also greatly relies on accurate timing as signals from satellites must be synchronised to be determine location precisely. Cesium based timekeeping is also implemented in aviation industry and the scientific research also benefits from cesium based timekeeping for experiments and observation.



Cesium is not just a fascinating element in the periodic table; it is a cornerstone of modern timekeeping. The ability to measure time with such precision has profound implications in technology, making cesium atomic clocks a remarkable achievement in the field of chemistry and physics

Aflah P

Ist MSc. Chemistry

MARIE CURIE



She was the first woman to win a Nobel Prize, the first individual to win it twice, and the only person to be honoured with Nobel Prizes in two distinct scientific fields.

In 1903, she shared the Nobel Prize in Physics with Pierre Curie, and physicist Henri Becquerel for developing the theory of "radioactivity".

In 1911, she received her second Nobel Prize, this time in Chemistry, for the discovery of the elements polonium and radium, using techniques she invented for isolating radioactive isotopes

In 1921, President Warren Harding of the United States, on behalf of American women, presented her with one gram of radium as a tribute to her contributions to science.

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

Marie Curie, born Maria Sklodowska on November 7, 1867, in Warsaw, Poland, was the daughter of a secondary school teacher. Growing up under Russian rule in a partitioned Poland, she excelled in education, receiving a general education from local schools and scientific training from her father. As a young adult, she became involved in a revolutionary students' organization, prompting her to leave Warsaw for Cracow. In 1891, Maria moved to Paris to pursue higher studies at the Sorbonne. Here, she adopted the name Marie and earned Licentiatehips in Physics and Mathematical Sciences, demonstrating her extraordinary academic prowess.

Marriage and Scientific Collaboration

Marie met Pierre Curie, a physics professor, in 1894, and they married the following year. Their union was not just personal but also profoundly professional, marking the beginning of groundbreaking research in radioactivity.

Despite challenging conditions, including inadequate laboratory resources and financial constraints, the Curies dedicated themselves to scientific inquiry.

The couple's research, inspired by Henri Becquerel's discovery of radioactivity in 1896, led to the discovery of the elements polonium, named in honor of Marie's homeland, and radium. Marie devised methods to isolate radium in sufficient quantities to study its properties, including its therapeutic applications.

Academic and Professional Milestones

Marie earned her Doctor of Science degree in 1903 and, after Pierre's untimely death in 1906, succeeded him as Head of the Physics Laboratory at the Sorbonne. She made history as the first woman to become a professor at the institution. In 1914, she was appointed Director of the Curie Laboratory at the University of Paris's Radium Institute, a center for cutting-edge research.

World War I and Humanitarian Work

During World War I, Marie Curie, with her daughter Irène, dedicated herself to using radiological science to alleviate human suffering. She established mobile X-ray units, known as "Little Curies," to aid battlefield medical efforts, directly assisting countless soldiers.

Legacy and Recognition

Marie Curie's achievements were

revolutionary and earned her global recognition. She became the first woman to win a Nobel Prize, sharing the 1903 Nobel Prize in Physics with Pierre Curie and Henri Becquerel for their work on spontaneous radiation. In 1911, she won a second Nobel Prize, this time in Chemistry, for her discoveries of polonium and radium and her ground-breaking studies in radioactivity.

Her honours include honorary degrees in science, medicine, and law, as well as memberships in esteemed societies worldwide. Notably, she and Pierre were awarded the Davy Medal by the Royal Society in 1903. In 1921, President Warren Harding of the United States presented her with one gram of radium on behalf of American women in recognition of her contributions to science.

Later Years and Enduring Influence

Marie remained deeply committed to her work throughout her life. She played a key role in establishing a radioactivity laboratory in Warsaw and served as a member of the Conseil du Physique Solvay from 1911 until her death. In 1922, she joined the Committee of Intellectual Co-operation of the League of Nations, further demonstrating her dedication to advancing science for societal benefit. Marie Curie passed away on July 4, 1934, from aplastic anemia, likely caused by her prolonged exposure to radiation.

Serin Mariya Raju
IInd B.Sc Chemistry

LIFE FROM STARDUST



THE ART OF CHEMISTRY IN STARS

Stars are celestial objects that can produce their own light. Stars are the fundamental building blocks of the universe, serving as both the forge for chemical elements and the engines of cosmic evolution. Stars begin their journey in vast clouds of gas and dust, primarily composed of mostly hydrogen, then helium and only trace amount of other elements. Under the influence of gravity, these materials collapse to form protostars. During this process, temperature rises eventually reaching levels high enough to initiate nuclear fusion – the process that powers stars. In a star’s core, hydrogen nuclei collide and fuse to form helium,

it thus releases huge amount of energy in the form of light and heat. This nuclear fusion is the cornerstone of stellar chemistry.



“Chemistry begins in the stars. The stars are the source of the chemical elements, which are the building blocks of matter and the core of our subject.”

Supernova is a powerful and luminous explosion of a star. A supernova occurs during the last evolutionary stages of a massive star or when a white dwarf is triggered into runaway nuclear fusion. The original object called the progenitor either collapses to neutron star or black hole or it is completely destroyed to form a diffuse nebula .



Nebula is a distinct luminescent part of interstellar medium which can consist of ionized, neutral or molecular hydrogen and also cosmic dust. Nebulae are often star-forming regions, such as in the Pillars of Creation in the Eagle Nebulae. In these regions, formations of gas dust and other materials clump together to form denser regions which attract further matter and thus it eventually becomes dense enough to form stars .

The core of a star is a high temperature, high pressure environment where nuclear fusion occurs. In main sequence stars like our Sun, hydrogen nuclei fuse to create helium through a series of reactions known as the proton-proton chain or carbon-nitrogen-oxygen cycle (CNO cycle). This fusion process is not only responsible for a star's energy output but also leads to the formation of heavier elements over time. As stars evolve, they exhaust their hydrogen fuel and the core contracts while temperatures rise. This triggers the fusion of helium into carbon. Carbon fuses to create oxygen and continue to produce even heavier elements up to iron through successive stages: carbon burning, neon burning and so on. When a massive star reaches the end of its life cycle, it undergoes a supernova explosion, dispersing these newly formed elements into space. This explosive event not only enriches the interstellar medium with heavy elements but also triggers the formation of new stars and planetary systems

Supernovae play a crucial role in the chemical evolution of galaxies. They are responsible for creating and distributing many of the heavier elements through processes such as neutron capture. These include slow neutron capture (S-process) and rapid neutron capture (R-process). S-process occurs in asymptotic giant branch stars, leading to the creation of elements like barium and lead. R-process takes place during supernova explosions or neutron star mergers, resulting in heavy elements like gold and uranium. The remnants of supernovae and stellar winds enrich surrounding gas clouds collapse under gravity, they can form new stars and planetary systems. The presence of essential elements such as carbon, nitrogen, oxygen and iron is crucial for the development of planets capable of supporting life.

Astronomers are now using advanced telescopes and spectroscopic techniques to study the chemical compositions of distant stars and galaxies. By analyzing the light emitted or absorbed by these celestial bodies, scientists can identify the presence of specific elements and compounds. This research not only enhances our understanding of stellar evolution but also aids in the search for extraterrestrial life by identifying potentially habitable environments elsewhere in the cosmos. The chemistry in stars is a magnificent dance of nuclear fusion and elemental creation that shapes the universe. From their fiery births to their explosive deaths, stars are responsible for synthesizing the very elements that compose our world. As we continue to explore the cosmos, we uncover more about how these celestial giants influence not just galaxies but also the origins of life itself.

Aleena Joy

IInd MSc. Chemistry

FROM RED TO BLUE

SIGNIFICANCE OF COLOR IN FRUITS AND VEGETABLES

Fruits and vegetables are not only essential for a balanced diet but also come in a vibrant array of colors, each offering unique nutritional benefits and phytochemicals.

The color of a fruit or vegetable often indicates its nutrient composition and potential health benefits. This article explores the significance of different colors in fruits and vegetables and their associated health benefits.

I. RED FRUITS AND VEGETABLES

- ✚ **Examples:** Tomatoes, red bell peppers, strawberries, cherries, raspberries.
- ✚ **Nutrients:** Rich in antioxidants, particularly lycopene and anthocyanins.
- ✚ **Health Benefits:** Red fruits and vegetables are known for their heart health benefits. Lycopene, found in tomatoes, has been linked to a reduced risk of certain cancers, especially prostate cancer. They also support immune function and may help reduce inflammation.



II. ORANGE AND YELLOW FRUITS AND VEGETABLES



- ✚ **Nutrients:** High in beta-carotene, vitamins C and A, and flavonoids.
- ✚ **Examples:** Carrots, sweet potatoes, oranges, mangoes, corn.
- ✚ **Health Benefits:** The carotenoids in orange and yellow fruits and vegetables promote eye health by reducing the risk of macular degeneration. They also enhance skin health and may boost immune response.

III. *WHITE AND BROWN FRUITS AND VEGETABLES*

- ✚ **Examples:** Cauliflower, onions, garlic, potatoes, mushrooms.
- ✚ **Nutrients:** Typically high in potassium, fiber, and other essential nutrients.
- ✚ **Health Benefits:** These foods are known for their heart health benefits. For example, garlic has been linked to lower blood pressure and improved cholesterol levels. They also provide immune-boosting properties.



IV. *GREEN FRUITS AND VEGETABLES*

- ✚ **Examples:** Spinach, kale, broccoli, green beans, avocados.
- ✚ **Nutrients:** Rich in vitamins K, C, and E, fiber, and various phytonutrients.
- ✚ **Health Benefits:** Green produce is known for its high levels of chlorophyll, which may aid in detoxification and promote healthy digestion. These foods are also linked to a reduced risk of chronic diseases, including heart disease and certain cancers.



V. *BLUE AND PURPLE FRUITS AND VEGETABLES*

- ✚ **Examples:** Blueberries, eggplants, purple grapes, plums, red cabbage.
- ✚ **Nutrients:** Contain anthocyanins, powerful antioxidant.
- ✚ **Health Benefits:** Blue and purple fruits and vegetables are associated with improved memory function and reduced risk of heart disease. They may also contribute to anti-inflammatory benefits and support healthy aging.



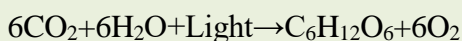
The diversity of colors in fruits and vegetables is not just visually appealing; it reflects a wide range of health benefits. Incorporating various colored fruits and vegetables into your diet can ensure a balanced intake of essential vitamins, minerals, and antioxidants, supporting overall health and reduces the risk of chronic diseases. And also it is a simple yet effective way to enhance your nutrition and promote a healthier lifestyle.

Dr. Sr. Sijo Francis
Assistant Professor

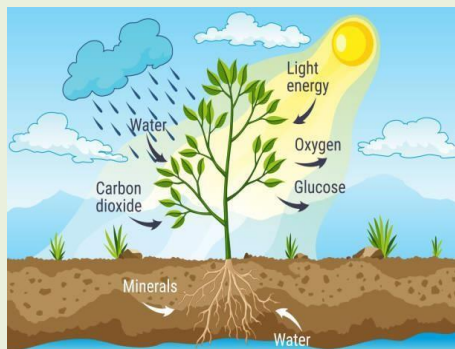
Chemistry is the invisible force that drives the processes of life and sustains our environment. From the tiniest atom to the vast atmospheric reactions, nature is a playground of chemical wonders that shape everything around us. Without chemistry, the natural world would cease to function as we know it. In this article, we explore four fascinating chemical processes that reveal the power and beauty of chemistry in nature.

Photosynthesis: The Engine of Life

Photosynthesis is the ultimate source of energy for nearly all life on Earth. This miraculous process allows plants to harness sunlight and convert it into chemical energy in the form of glucose, which fuels plant growth. This reaction occurs inside the chloroplasts of plant cells, primarily in the leaves. The heart of photosynthesis is chlorophyll, the pigment that gives plants their green color. Chlorophyll absorbs sunlight and, with the help of water (H₂O) and carbon dioxide (CO₂), converts this energy into glucose (C₆H₁₂O₆) and releases oxygen (O₂) into the atmosphere. This oxygen is vital for the survival of animals and humans. The simplified chemical equation for photosynthesis looks like this:

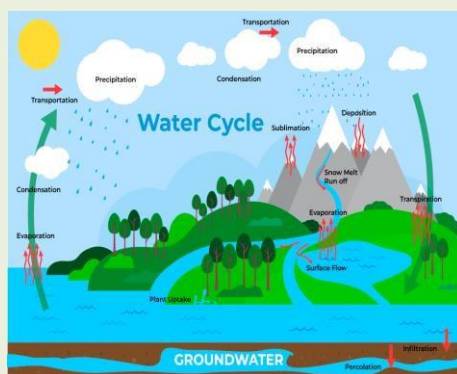


This process demonstrates how nature uses basic chemistry to create a self-sustaining cycle of energy. Without photosynthesis, life on earth as we know it would not exist, as plants form the base of nearly every food chain.



The Water Cycle: Nature's Recycling

Water, often called the "universal solvent," is involved in countless chemical processes that sustain life. One of the most crucial is the **water cycle**, which involves the continuous movement of water in different states—liquid,



vapor, and solid—throughout the Earth's surface and atmosphere. This cycle is driven by physical and chemical changes. When water evaporates from oceans, rivers, or plants, it rises into the atmosphere as water vapor (gas). As it cools, it condenses into tiny droplets, forming clouds. Eventually, these droplets gather and fall back to Earth as precipitation (rain, snow, or hail). Some of this water is absorbed by plants and animals, while the rest returns to bodies of water, restarting the cycle.

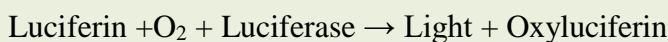
At the molecular level, water's structure allows it to easily change states due to the breaking and forming of hydrogen bonds, a process governed by temperature and pressure. These chemical transitions are key to maintaining Earth's water balance and supporting life in ecosystems.

Bioluminescence: Nature's Light

Imagine walking through a forest at night and witnessing the soft glow of fireflies or the eerie blue light of deep-sea creatures. This is bioluminescence, the production and emission of light by living organisms—a stunning example of chemistry at work in nature.



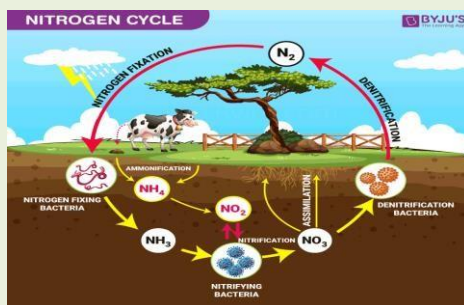
Bioluminescence occurs through a chemical reaction between luciferin, a light-emitting molecule, and luciferase, an enzyme that catalyzes the reaction. When luciferin reacts with oxygen in the presence of luciferase, light is produced as a byproduct. This reaction can be written as:



Bioluminescence serves various purposes in nature: some organisms use it to attract mates, while others use it to lure prey or scare off predators. The ocean is full of bioluminescent organisms, including certain species of jellyfish, fish, and algae, making it one of the most spectacular examples of chemistry in the natural world.

Soil Chemistry: The Earth's Nutrient Bed Show

Beneath our feet lies a bustling world of chemistry that provides nutrients essential



for plant growth. Soil chemistry involves a complex interaction between organic matter, minerals, and living organisms. The key nutrients that plants absorb from soil are nitrogen (N), phosphorus (P), and potassium (K)—often referred to as NPK, the building blocks of life.

Microorganisms in the soil play a critical role in breaking down organic matter, releasing these vital nutrients that plants need to grow. Nitrogen, for example, is converted by soil bacteria into ammonia (NH_3) through a process called nitrogen fixation. This ammonia is then transformed into forms that plants can absorb, such as nitrates (NO_3^-). Soil's pH, determined by the concentration of hydrogen ions (H^+), is also important. If the soil is too acidic or too alkaline, it can affect the availability of nutrients to plants, influencing their growth and health.

From the plants that fuel life to the invisible gases in our atmosphere, chemistry is the silent architect behind many of nature's most wondrous phenomena. Understanding these processes not only deepens our appreciation for the natural world but also reminds us of the intricate balance that sustains life on Earth. By studying the wonders of chemistry around us, we can work toward preserving these natural marvels for future generations.

Aafiya Mannel
Ist M.Sc Chemistry

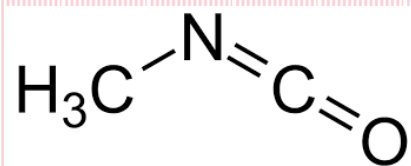
CHEMICAL DISASTERS

Chemical accidents refer to the unintentional release of hazardous substances, posing significant risks to human health and the environment. These incidents can range from minor mishaps to major disasters, with their severity depending on the type and quantity of chemicals involved. Such accidents often have far-reaching consequences, including air and water pollution, soil contamination, and long-term health issues for affected populations. They occur in various contexts, such as industrial facilities, transportation of chemicals, or even in residential areas due to improper handling or storage. This article highlights the importance of understanding chemical accidents by examining two notable case studies to explore their impact on human health and the environment.



Bhopal Gas Tragedy

The Bhopal Disaster, occurred on the nights of December 2-3, 1984, in Bhopal, Madhya Pradesh. A catastrophic leak of the toxic gas methyl isocyanate (MIC) from a pesticide plant owned by Union Carbide India Limited devastated the city. In addition to MIC, other highly poisonous gases, such as phosgene, were also released into the atmosphere.



The city was engulfed in a lethal gas cloud, resulting in an immediate death toll of approximately 3,787 people, according to the Madhya Pradesh government. In the weeks that followed, another 300 fatalities were reported, with an estimated 8,000 lives eventually claimed by gas exposure-related illnesses.

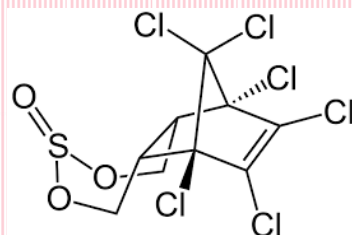


Beyond the immediate loss of life, around 4,000 individuals sustained severe and permanent disabilities, while 50,000 more suffered from temporary or partial health effects.

Investigations into the disaster revealed gross negligence, including substandard safety protocols, inadequate staffing, and deficient operational procedures at the plant. The long-term consequences were profound, with reports indicating that the tragedy affected future generations, including health complications among children born to survivors.

Endosulfan Tragedy

The Endosulfan tragedy occurred in Kasaragod district, Kerala, due to the extensive use of the pesticide Endosulfan, which was developed in 1954. For several years, Endosulfan was widely used in cashew plantations across Kasaragod, as well as in tea plantations, paddy fields, and fruit orchards in other parts of Kerala. It was applied through aerial spraying and manual pumps. The pesticide, prone to long-range atmospheric transport, was linked to severe health disorders among residents in the affected areas.



In 2001, tests conducted by the Centre for Science and Environment in Padre village, Kasaragod, confirmed the hazardous effects of Endosulfan. Responding to the growing evidence of harm, the Kerala government banned its use in 2005.



However, neighboring states continued to use the pesticide. In 2011, the Stockholm Convention on Persistent Organic Pollutants (POPs) imposed a global ban on the manufacture and use of Endosulfan. The same year, the Supreme Court of India prohibited its use, manufacture, and distribution nationwide. A court-appointed panel recommended phasing out the pesticide over two years to mitigate the high cost of incinerating stockpiles.

Sreedevi Sugathan
IInd B.Sc Chemistry

To the greatest benefit to humankind since 1901

To those who, during the preceding year, shall have conferred the greatest benefit on mankind” is awarded Nobel Prize in chemistry.

The Nobel Prize is an international award administered by the Nobel foundation in Stockholm, Sweden, and based on the fortune off Alfred Nobel, Swedish inventor and entrepreneur.

INSPIRATIONS AND FACTS BEHIND NOBEL PRIZES



The Nobel prizes are widely regarded as the most prestigious awards given for intellectual achievement in the world. In the will he drafted in 18895, Nobel instructed that most of his fortune be set aside as a fund for the awarding of five annual prizes “to those who, during the preceding year, shall have conferred the greatest benefit on mankind”. These prizes as established by his will are the Nobel Prize for physics, the Nobel Prize for chemistry, the Nobel Prize for physiology or medicine, the Nobel Prize for literature, and the Nobel Prize for peace. The first distribution of the prizes took place on December 10, 1901, the fifth anniversary of Nobel’s death. An additional award, the sveriges Riksbank prize in Economic

Science in Memory of Alfred Nobel, was established in 1968 by the Bank of Sweden and was first awarded in 1969. The Nobel Prize money for 2023 in Indian Rupee is 8.1 crore. That is, Sweden kronor (SEK) 11.0 million per full Nobel Prize.

Chemistry was the most important science for Alfred Nobel's own work. The development of his inventions as well as the industrial processes he employed were based upon chemical knowledge. Chemistry was the second prize area that Nobel mentioned in his will. The Nobel Prize in Chemistry is awarded by the Royal Swedish Academy of Sciences, Stockholm, Sweden. Although Richard Kuhn (1938, chemistry), Adolf Butenandt (1939, chemistry), and Gerhard Domagk (1939, physiology or medicine) were forced to decline their Nobel awards, the men later received their diplomas and medals. There have been eight years for which the Nobel Prize in Chemistry was not awarded.

The Nobel Prize in Chemistry has been awarded 116 times to 197 Nobel Prize laureates between 1901 and 2024. Frederick Sanger and Barry Sharpless have both been awarded the Nobel Prize in Chemistry twice. This means that a total of 195 individuals have received the Nobel Prize in Chemistry. Also, the Nobel Prize in Physics was awarded to John Bardeen twice, as was the Nobel Prize in Chemistry to Frederick Sanger and Karl Barry Sharpless. Two laureates have been awarded twice but not in the same field: Marie Curie (Physics and Chemistry) and Linus Pauling (Chemistry and Peace). Only one woman, Marie Curie, has been honored twice, with the Nobel Prize in Physics 1903 and the Nobel Prize in Chemistry 1911. This means that 65 women in total have been awarded the Nobel Prize between 1901 and 2024.

In 1901, Jacobus Henricus Vant Hoff (1852-1911) received the first Nobel Prize in Chemistry. Venkataraman Ramakrishnan shared the 2009 Nobel Prize in Chemistry with Ada E. Yonath and Thomas A. Steitz "for studies of the structure and

function of the ribosome”. The Nobel Prize in Chemistry 2024 was awarded with one half to David Baker “for computational protein design” and the other half jointly to Demis Hassabis and John M. Jumper “for protein structure prediction”. Demis Hassabis and John Jumper have successfully utilized artificial intelligence to predict the structure of almost all known proteins. David Baker has learned how to master life’s building blocks and create entirely new proteins.

The Nobel Prize Inspiration Initiative (NPII) is a global programme designed to help Nobel Laureates share their inspirational stories and insights. By taking Nobel Prize laureates on visits to universities and research centers around the world, and by capturing their thoughts on video, the initiative seeks to bring the laureates into closer contact with the worldwide scientific community, and especially with an audience of young scientists.

Dr. Jose James
Assistant Professor

CHEMISTRY BEHIND THE EMOTION “HAPPINESS”

WHAT ARE EMOTIONS?

Emotions are subconscious physiological responses to internal or external events. Although emotions and feelings are related, feelings arise from emotions and cannot be used interchangeably. Feelings are personal and shaped by conscious thought and reflection. For example, if we experience the anger, we may also feel frustrated or confused.

Our emotion can be; happiness, sadness, anger, fear, surprise, and disgust. Positive emotions like happiness makes us feel satisfied, which can enhance motivation and focus. On the other hands, negative emotions, such as anger, can drain your energy and reduce your effectiveness.

SEROTONIN: *the feel-good neurotransmitter*

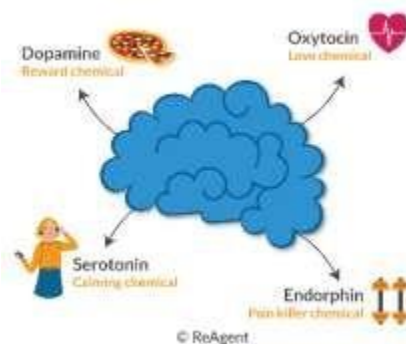
Serotonin is a monoamine neurotransmitter that is biologically synthesized from tryptophan, an essential amino acid. It is a primary amino compound and specifically a 5-hydroxy derivative of tryptamine. The

HOW DOES SUCH A VARIETY OF EMOTIONS OCCUR? DOES OUR BRAIN PLAYS ANY ROLE IN IT?

Our emotions arise due to a series of chemical reactions in our brains, managed by the complex teamwork of neurotransmitters and hormones. These chemicals helps your brain in understanding, evaluating, and communicating your experiences as you sense a situation and respond to it. Each neurotransmitter and hormone have a specific role, activated in distinct ways to signal particular emotions and stimulate various areas of the brain.

When it comes to happiness, the key chemicals that signal it are

- ✚ serotonin
- ✚ Dopamine
- ✚ Oxytocin
- ✚ Endorphin



mechanism of serotonin begins with oxidation of serotonin by monoamine oxidase, producing 5-hydroxyindoleacetaldehyde (5-HIAL). The rate determine step is the transfer of a

hydride ion from serotonin to a cofactor. Further, aldehyde dehydrogenase (ALDH) oxidizes 5-HIAL to form 5-hydroxyindoleacetic acid (5-HIAA).

Serotonin, commonly known as the 'feel-good neurotransmitter' due to its significant role in promoting feelings of happiness and well-being, is found mainly in the brain, gastrointestinal tract, and blood platelets. It acts as a natural mood stabilizer and has a significant impact on various bodily functions, including sleep, digestion, and appetite regulation. This important chemical contributes to bone health, stimulates nausea, assists in wound healing, helps to reduce anxiety and is a powerful antidepressant.

DOPAMINE: the pleasure and reward molecule

Dopamine is a type of neurotransmitter

Dopamine deficiency is linked to mood disorders like depression, causing low motivation and joy in activities. This can create a cycle of negative emotions and further dopamine depletion. However, you can boost dopamine levels through quality sleep, a low-saturated fat diet, regular exercise, meditation, and listening to music.

OXYTOCIN: the love hormone

Oxytocin is a significant peptide hormone and neuropeptide that is mainly produced in hypothalamus and released by the posterior pituitary gland. From there, oxytocin is routed to the spinal cord or various other regions of the brain based on its purpose. It is classified as a nonapeptide, since oxytocin consists of

produced in hypothalamus, which helps to transmit signals in the brain. It belongs to two families of chemicals called catecholamines and phenethylamines. It is also known as 4-(2-aminoethyl) benzene-1,2-diol and is important for motivation. Dopamine is made from an amino acid called tyrosine. Tyrosine is first converted into another amino acid called L-dopa. Enzymes then change L-dopa into dopamine.

Dopamine is a brain chemical essential to the reward system, influencing feelings of happiness and excitement. Higher dopamine levels generally lead to satisfaction, while negative emotions like fear or sadness can also trigger dopamine release. However, how this affects a person's mood can vary based on the situation and individual difference.

nine amino acids. Its precise sequence is cysteine-tyrosine-isoleucine-glutamine-asparagine-cysteine-proline-leucine-glycine-amide. The molecular structure of oxytocin is characterized by a cyclic formation, stabilized by a disulfide bridge that links the two cysteine residues, which is essential for its biological activity.

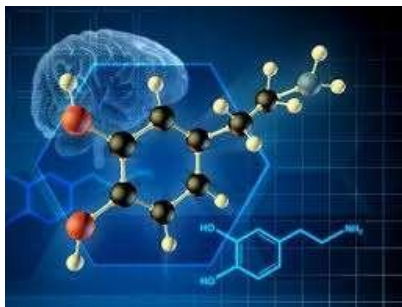
Oxytocin is commonly known as the "love hormone" because of its powerful impact on social bonding, emotional regulation, and behaviours associated with trust and empathy. This hormone is crucial for various physiological and behavioural processes, especially during childbirth and lactation. Oxytocin can help lower stress and anxiety while enhancing social behaviours such as trust, empathy, forming positive memories, recognizing bonding cues, and facilitate effective communication.

ENDORPHINS: the body's natural painkillers

Endorphins are opioid peptides synthesized by the hypothalamus and pituitary glands, functioning as neurotransmitters in the brain. They include three main types: α -endorphin, β -endorphin, and γ -endorphin. These peptides are derived from a precursor protein known as proopiomelanocortin (POMC), and they all share a common

In conclusion, Engaging in activities that boost the release of "feel-good" neurotransmitters, such as exercise, social interaction, and mindfulness practices, can help to cultivate greater happiness and life satisfaction.

Ultimately, the chemistry of happiness is a complex and fascinating topic that highlights the remarkable adaptability and resilience of the human brain. By nurturing our neurochemical well-being, we can unlock our full potential for joy, fulfilment, and emotional resilience.



N-terminal sequence: Tyr-Gly-Gly-Phe-Met.

Endorphins are often called the body's natural painkillers because they are released when we feel pain or stress. One of the best ways to increase endorphins is through physical activity; the more you exercise, the more endorphins your body produces. In addition to exercise there are other enjoyable ways to increase the endorphin level, which include leisurely walk, joking with friends, watching TV, listening music, having dark chocolate etc.. Additionally some researches shows that being kind showing empathy can enhance endorphin production.

Prettina P Varghese
IInd MSc. Chemistry

UNVEILING PHARMACEUTICAL CHEMISTRY

Pharmaceutical chemistry is a vital branch of chemistry that focuses on the design, development, and analysis of pharmaceutical compounds. This field integrates various scientific disciplines, including organic chemistry, medicinal chemistry, analytical chemistry, and biochemistry, to ensure the creation of safe and effective medication.

DRUG DESIGN AND DISCOVERY

- **Structure-Activity Relationship (SAR)**- Understanding the relationship between a drug's chemical structure and its biological activity is crucial. SAR studies involve modifying molecular structures to enhance potency and selectivity while minimizing side effects.
- **Quantitative Structure-Activity Relationship (QSAR)**- QSAR modeling uses statistical methods to correlate chemical structure with biological activity quantitatively. By analyzing data from known compounds, chemists can predict the activity of new candidates before synthesis.
- **Molecular Docking**- This computational technique simulates the interaction between a drug candidate and its biological target (often a protein). By predicting binding affinities, researchers can prioritize compounds for synthesis and biological testing.

SYNTHETIC STRATEGIES

The synthesis of active pharmaceutical ingredients (APIs) often involves complex multi-step processes. Common strategies include:

- **Retrosynthetic Analysis:** Breaking down complex molecules into simpler precursors helps identify feasible synthetic routes.
- **Asymmetric Synthesis:** Techniques such as chiral catalysts





are employed to produce enantiomerically pure compounds, which are critical for drug efficacy and safety.

➤ **Green Chemistry:** Emphasizing environmentally friendly methods.

Techniques Include:

- High-Performance Liquid Chromatography (HPLC): Used for separating and quantifying components in a mixture, HPLC is crucial for purity analysis.
- Mass Spectrometry (MS): It compounds based on their mass-to-charge ratio, providing information about molecular weight and structure.
- Nuclear Magnetic Resonance Spectroscopy: It is utilized to determine the structure of organic compounds by analyzing the magnetic properties of atomic nuclei.

The formulation of drugs into suitable delivery systems is essential for therapeutic efficacy. Various methods include:

- Tablets and Capsules: Solid dosage forms that provide controlled release of the active ingredient
- Injectable: Solutions or suspensions administered via injection for rapid systemic effect.
- Transdermal Patches: Deliver drugs through the skin for systemic effects, allowing for sustained release over time.

Understanding how drug properties influence absorption and bioavailability is crucial. Factors like solubility, permeability, and stability affect how well a drug performs in the body.

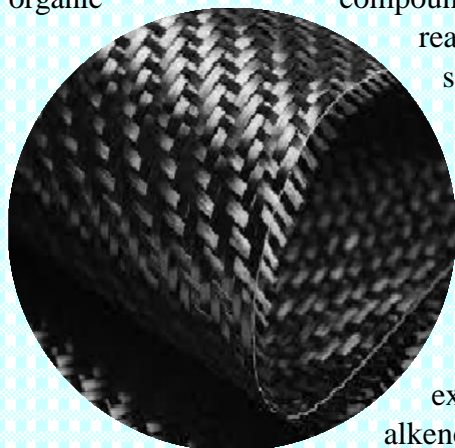
Nandhana Sunil
IInd MSc. Chemistry

CARBON: BACKBONE OF ORGANIC CHEMISTRY

Organic chemistry is the branch of chemistry which deals with the structures, properties and reactions of organic compounds, which are based primarily on carbon. Carbon holds a unique and central role in organic chemistry due its versatility, ability to form different structures and capability to bond with variety of elements.

Carbon becomes the 'backbone' of all organic molecule due to the unique properties such as tetravalency, catenation, bonding with other elements, isomerism etc. The valence number of electrons in carbon is four which means it can form four covalent bond with other atoms. And this forms stable, complex molecules of different sizes and shape. For example, carbon can bond with hydrogen to form hydrocarbons or with oxygen, nitrogen, and other elements to create variety of functional groups.

The exceptional ability of the carbon to form long chains or rings of atoms bonded together is called catenation. There are straight, branched or cyclic chains leading to an immense variety of organic compounds. Carbon's ability to catenate is largely responsible for the structural diversity of organic



compounds. Carbon readily forms single, double and triple bonds with a wide range of elements, especially hydrogen, oxygen, nitrogen, sulphur and halogens. This ability to form various types of bonds affects the reactivity and properties of the molecules it forms. For example, the carbon-carbon double bonds in alkenes and triple bonds in alkynes introduce varying



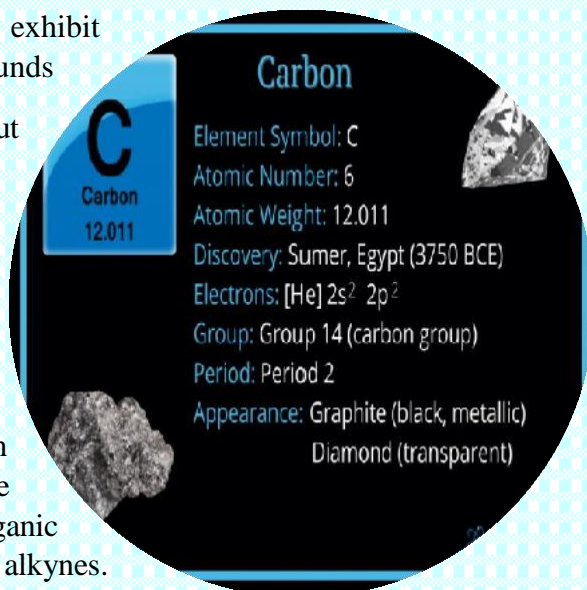
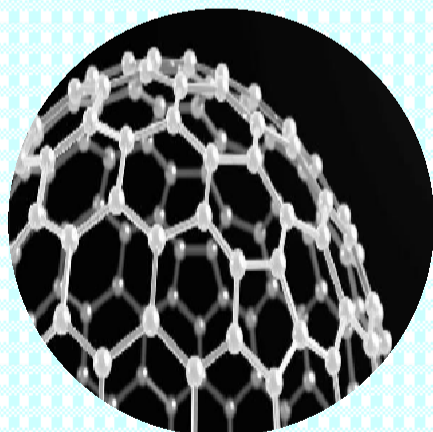
degrees of rigidity and reactivity into the compounds.

Carbon containing compounds often exhibit isomerism, where two or more compounds

have same molecular formula but different structural arrangements. This structural variations affect the physical and chemical properties of the compounds. For example, butane and isobutane share the same molecular formula but differ in their structure and boiling points due to their branching. The Carbon-Hydrogen compounds or hydrocarbons form the simplest and most basic type of organic molecules such as alkanes, alkenes and alkynes.

Hydrocarbons are the basis for more complex molecules and play a significant role in the energy industry, where they are used as fuels.

Carbon is the building block of life, found in biomolecules like carbohydrates, lipids, proteins, and nucleic acids. These molecules are essential for the structure and function of living organisms. For example, carbon forms the backbone of DNA and RNA, allowing the storage and transmission of genetic information. Carbon is also a crucial element in the global carbon cycle, where it moves between the atmosphere, biosphere, oceans, and geosphere. This cycle plays a critical role in regulating Earth's climate. Organic carbon compounds, such as those found in fossil fuels, are an essential energy source for human activity but also contribute to environmental challenges like climate change due to carbon dioxide emissions.



Carbon

Element Symbol: C
Atomic Number: 6
Atomic Weight: 12.011
Discovery: Sumer, Egypt (3750 BCE)
Electrons: [He] 2s² 2p²
Group: Group 14 (carbon group)
Period: Period 2
Appearance: Graphite (black, metallic)
Diamond (transparent)

Carbon's unparalleled versatility, its ability to form a variety of stable bonds and structures, and its central role in biological and environmental processes make it the backbone of organic chemistry. From simple hydrocarbons to complex biomolecules, carbon's presence is the foundation upon which organic chemistry is built, enabling the diversity and richness of life as we know it.

Gopika Shaji
IInd M.Sc Chemistry

CATALYSTS: ENHANCING DAILY LIFE PROCESSES

"CATALYST OFFER THE PROMISE OF MAKING CHEMICAL TRANSFORMATIONS FAR LESS POLLUTING"

Catalyst is a chemical substance that increases the rate of a chemical reaction without undergoing any permanent chemical change itself. It doesn't take part in the chemical reaction but provides condition for the reaction to happen. Generally, catalyst are used to speed up the chemical reaction, however it can also be used in various real life applications such as environmental cleaning, etc. A Catalyst plays a vital role in many industries such as the pharma and environmental fields. Their ability to enhance the efficiency, selectivity, and economy of chemical processes makes them suitable for various real life applications. Some of the real life applications of catalysts are mentioned below:

- Environmental Cleaning
- Petrochemical Industry
- Pharmaceutical Synthesis
- Food Production
- Sustainable Energy

Environmental Cleaning

Catalysts are used in environmental cleaning processes to degrade pollutants and contaminants in air and water. There, catalysts bring about the change in the harmful pollutants that are transformed into 'less toxic' by-products.

For Example: Cars use automotive catalytic converters, which use catalysts containing platinum and rhodium to change undesirable gases from the engine into harmless gases like carbon dioxide. It helps in the reduction of emissions from vehicles and from keeping the air clean.

Pharmaceutical Synthesis

In pharmaceutical synthesis, catalysts play an important role in enabling efficient and selective chemical transformations to produce pharmaceutical compounds. Catalysts help optimize reaction conditions, increase



reaction rates, and improve product yields, contributing to the development of safe and effective drugs.

For Example: While producing medicines catalysts are employed to accelerate the chemical reactions. They help to develop new drugs that are accessible and produced in larger quantities such as aspirin or antibiotics.

Food Production

In food production, catalysts are utilized in various processes to improve efficiency, enhance quality, and reduce production costs. They quicken reactions during food processing when used which bring out the flavour, texture, and also enhance the nutritional value.

For Example: In bread baking, enzymes have the function to assist the dough to rise. They digest sugars in the dough thereby triggering the release of gases that make the bread fluffy. Similarly, in cheese making enzymes are useful in the fermentation process, resulting in distinctive taste and texture of cheese.

Sustainable Energy

Catalysts enable the conversion of renewable energy resources like biodiesel and hydrogen fuel cells to be produced.

They accelerate the conversion of biomass to biofuels by producing numerous types of clean energy.

For Example: In biodiesel development, catalysts are used to convert vegetable oils and animal fats into a much cleaner fuel. This process is called trans esterification. This would reduce our dependence on fossil fuels and the encouraging of renewable resources to be used as an energy sources.



Catalysts play the vital roles of the changers in the various fields of our lives. Whether it's producing cleaner air, improving industrial processes, or advancing medicine and green energy, their effect is unquestionable. At each juncture, catalysts lays down the basis for a greater, brighter, and cleaner future generations.

Amritha P

Ist M.Sc Chemistry

Clean Water Through Nanotechnology: An Insight into Dr T Pradeep's Research

This article is a narration of my vivid memory of meeting Dr T Pradeep, Professor in the Department of Chemistry at IIT Madras and a renowned scientist in nanoscience.

Life @ IISER Bhopal

At IISER Bhopal, it is mandatory for BS-MS students to carry out a major project under a faculty member during the final year of the BS-MS course. In the summer of 2014, I joined the Ultrafast Spectroscopy lab of Dr Saptarshi Mukherjee for my project work. I was fortunate to have a lot of spare time that year because my work entailed little chemical synthesis. Like my colleagues I mostly focussed on appearing for competitive exams during this time. Students who are interested in a PhD abroad would prepare for exams like GRE (English and subject GRE), TOEFL and if possible, would publish a research paper. While those students interested in a PhD in India would focus on NET or GATE exams. I decided to give a try for both, as I was not sure which the path that would work out for me.

PhD interview @ IIT Madras

Once I qualified GATE, I applied for a PhD position at IIT Madras. It was during my PhD interview at IIT Madras, I first met Dr T Pradeep. He was present in my interview committee. Later I saw him outside the interview hall. I approached him, introduced myself, and expressed my interest in joining his lab for research. We had a chit chat and since he was heading to his lab, he asked me if I would like to visit the lab, which I happily accepted. He asked one of his research students to give me a tour of the lab facilities. After that he wished me good luck, I thanked Dr Pradeep for his generosity and left IIT Madras, back to IISER Bhopal.

To keep in touch, I later mailed him my CV and mark list as asked by Dr Saptarshi. To my surprise he replied but by saying there was no PhD position available in his lab right now. However, he asked me to join for a skype meeting with him. During the call he offered me a PhD position in one of his collaborative works at Canada. And the rest is history (I joined St Joseph's College, Moolamattom as a teacher).

Dr Thalappil Pradeep

It was only after my meet up with Dr Pradeep I actually studied about him and his research works. At IIT Madras, I had seen a prototype of a water purification system invented by Dr Pradeep. It was named "AMRIT" and used to fight arsenic contaminated water.



- Current Position: Professor, Department of Chemistry, Indian Institute of Technology Madras (1993 – present)
- Alma mater: Indian Institute of Science, Bangalore (PhD), University of California, Berkeley (Post-doc), Purdue University, Indiana (Post-doc).
- Birth place: Panthavoor, Malappuram, Kerala
- h-index- 93
- Recognitions: Shanti Swaroop Bhatnagar Prize, Padma Shri
- Books: Nano: The Essentials Understanding Nanoscience and Nanotechnology, A Textbook of Nanoscience and Nanotechnology etc.

Research areas

T. Pradeep is known for his significant contributions in the fields of nanoscience, materials chemistry, and environmental science.

Water Purification

One of Pradeep's most widely recognized research areas is water purification. His group found that noble metal nanoparticles degrade halocarbons efficiently to amorphous carbon and metal halides at room temperature and at low concentrations. This discovery has led to the world's first nanochemistry based water filter for pesticide removal as many pesticides of relevance are halocarbons.



His nanomaterials-based water technology AMRIT is running successfully in the country to remove arsenic from drinking water. Previously it was thought that arsenic is present only in West Bengal but now it is found in all parts of India. According to water resources ministry, 65 percent of

Assam population (21 million people), 60 per cent in Bihar and 44 per cent in West Bengal drink arsenic-contaminated water.

Dr Pradeep's filter is working in more than 900 locations in India serving about 600,000 people. He has patented this technology in 2013. Several other drinking water technologies have also rolled out from his lab. To take such technologies forward, four companies been incubated with the participation of IIT Madras.

Other works

Pradeep has made significant contributions to the synthesis and application of nanomaterials. He has been involved in the development of nano-based sensors for detecting hazardous substances, including chemicals, biological agents, and pollutants. His work in this area includes the use of quantum dots and nanosensors for high sensitivity and selectivity in environmental monitoring and medical diagnostics. Further, he has investigated the use of nanomaterials in energy storage and conversion systems, including batteries, supercapacitors, and fuel cells with a goal to improve the performance and longevity of energy devices using nanotechnology.

Ms Deena Paul
Assistant Professor

BEAUTY MEETS CHEMISTRY

The Chemistry Behind Your Favourite Beauty Products.

Cosmetic chemistry is the fascinating science behind the beauty products we use every day. This branch of chemistry focuses on the formulation and development of cosmetics, including skincare, haircare, and makeup products.

Cosmetic Chemistry Involves

1. **Formulation Science:** This involves creating stable mixtures of ingredients that deliver desired effects. Formulation chemists ensure products have the right texture, consistency, and efficacy.

2. **Ingredient Innovation:** Advances in cosmetic chemistry lead to the discovery and use of novel ingredients. These can include natural extracts, synthetic compounds, and biotechnologically derived substances that offer unique benefits.

3. **Safety and Efficacy Testing:** Ensuring the safety and effectiveness of cosmetic products is crucial. This involves rigorous testing and compliance with regulatory standards to ensure products are safe for consumer use.

4. **Sustainability:** With growing environmental concerns, cosmetic chemists are focusing on sustainable practices. This includes developing eco-friendly packaging, using renewable resources, and creating biodegradable formulations.

How Cosmetic Chemistry Creates Cosmetics?

Formulation Chemistry: The core of cosmetic chemistry is formulation, which involves the creation of stable, effective mixtures that deliver the desired functional properties.

Formulation involves selecting and blending active ingredients with excipients, solvents, and stabilizers. Each formulation must be designed to meet the specific characteristics required for the final product, such as viscosity, spread ability, texture, stability, and safety.



1. **Active Ingredients:** These substances responsible for providing the therapeutic or cosmetic benefit to the product. During formulations, these ingredients may target specific skin or hair concerns such as hydration, anti-aging, pigmentation, or acne.

- a. **Humectants:** Substances like glycerin, hyaluronic acid, and propylene glycol attract and retain moisture in the skin, preventing transepidermal water loss (TEWL).
- b. **Exfoliants:** Alpha-hydroxy acids (AHAs) such as glycolic acid and beta-hydroxy acids (BHAs) like salicylic acid act to promote the shedding of dead skin cells, improving skin texture and appearance.

2. **Preservatives and Microbial Control:** The stability and Shelf-life of cosmetic products depends on their ability to resist microbial contamination. **Preservatives** are critical to prevent the growth of bacteria, fungi, and mold in aqueous formulations. Common preservatives include parabens, phenoxyethanol, and sodium benzoate

3. **Solubility and Stability:** Water, oils, and alcohols are the most common solvents used in cosmetics. However, solubility can be influenced by the pH, ionic strength, and polarity of both the active ingredients and the solvents used.

4. **pH control** is another critical factor in cosmetic formulations. The skin has an average pH of 4.5 to 5.5, and most cosmetic products must be formulated to match this pH to avoid irritation. Adjusting pH is done with **acidulants** (e.g., citric acid) or **alkalizing agents** (e.g., sodium hydroxide).



Cosmetic chemists play a vital role in the beauty industry. They combine their knowledge of chemistry with creativity to develop innovative products that meet consumer needs and preferences. Their work involves researching new ingredients, improving existing formulations, and ensuring products are safe and effective.

Cosmetic chemistry is not just about making product look and smell good; it's about enhancing the overall well-being of consumer

Cosmetic chemists blend science and art to create products that help people look and feel their best.

Nandhu Shaji
IInd MSc. Chemistry



THE SCIENCE BEHIND

FLAVOUR AND AROMA

Flavors and aromas are what make fresh fruits and vegetables delightful to our senses, playing a crucial role in their overall quality. But have you ever wondered what gives a ripe mango its irresistible sweetness or a fresh tomato its unique tang? The answer lies in chemistry.

Flavor vs. Aroma: What's the Difference?

Flavor is a multisensory experience—a combination of taste and aroma that creates the overall perception of a food's essence. On the other hand, aroma refers specifically to the smell or odor that wafts up, giving us that first impression of freshness or ripeness.

Taste buds on our tongue pick up five main tastes: sweet, salty, sour, bitter, and umami.

The Chemistry behind the Magic

The delightful flavors and captivating aromas of fruits and vegetables come from a complex mix of chemical compounds. Among these are volatile organic compounds, responsible for the distinctive scents we associate with fresh produce. Interestingly, these compounds exist in incredibly tiny amounts—often less than 30 parts per million. Yet, even at these minuscule concentrations, they pack a powerful sensory punch.

How Are These Compounds Formed?

Biochemical processes within fruits and vegetables drive the formation of flavor and aroma compounds. Enzymatic reactions during growth, ripening, and even after harvest create the distinct profiles of each fruit or vegetable. For example, the sweetness of a ripe strawberry comes from the breakdown of sugars, while its aroma is due to a mix of esters and other volatiles.



The flavour of the food can be altered with natural or artificial flavourants which affect these senses. Natural flavoring substances are obtained from plant or animal raw materials, by physical, microbiological or enzymatic processes. They can be either used in their natural state or processed for human consumption. The natural flavorants are first extracted from the source substance by solvent extraction, distillation, or using force to squeeze it out. The extracts are then usually purified and subsequently added to food products to flavor them.

- **Esters:** Provide fruity aromas
- **Terpenes:** Provide citrus or herbal notes
- **Aldehydes:** Impart floral or sweet scents
- **Ketones:** Provide fruity or musty notes
- **Lactones:** Contribute to the aroma of fruits, butter, cheese, vegetables like celery, and other foods
- **Alcohols:** Improve flavors and aromas and sometimes textures of food
- **Diacetyl:** Has a distinctive buttery aroma and is commonly used to impart flavor to numerous food products

An artificial flavorant is a substance that gives another substance flavor, altering the characteristics of the solute, causing it to become sweet, sour, tangy, etc. e.g. different flavors due to the use of different scents or fragrances in artificially flavored jellies, soft drinks and candies, which are made of bases with a similar taste. Artificial flavorings are focused on altering or enhancing the flavors of natural food product such as meats and vegetables, or creating flavor for food products that do not have the desired

flavors such as candies and other snacks. Most types of flavorings are focused on scent and taste. Few commercial products exist to stimulate these senses, since these are sharp, astringent, and typically unpleasant flavors. Flavor compounds can make food taste fresh or spoiled. They are molecules that our tongues and noses sense, which tell us how food tastes and smells. Good flavors mean the food is likely safe to eat, while bad ones warn us it would be harmful.

Understanding flavor chemistry allows us to appreciate the intricate science behind the taste of our food. By delving into the molecular basis for taste, we gain a deeper understanding of how our taste buds perceive flavors.

Fathima Farisa
IInd M.Sc Chemistry

The Science behind Culinary Innovation

MOLECULAR GASTRONOMY

The term molecular gastronomy is credited to Hungarian physicist Nicholas Kurti and French chemist Hervé This. They applied food science to explain and solve culinary issues. Old kitchen tales and cooking tips were collected and tested to support their principles. As a result of their curiosities, a new area of discussion, practice and study emerged: molecular gastronomy. It is a branch of food science that approaches the preparation and enjoyment of nutrition from the perspective of a scientist at the scale of atoms, molecules, and mixtures.



Molecular gastronomy is the scientific approach of cuisine from primarily the perspective of chemistry. The composition (molecular structure)• properties (mass, viscosity, etc.) and transformations (chemical reactions

reactant products) of an ingredient are addressed and utilized in the preparation and appreciation of the ingested products.



Melona's signature preparation is an edible floral center piece named the "Octopop": a very low temperature cooked octopus fused using transglutaminase, dipped into an orange and saffron carrageenan gel and suspended on dill flower stalks.

Some techniques used in molecular gastronomy include:

- **Gelification:** Turning a purée into a gel.
- **Whipping:** Turning a liquid into a foam
- **Spherification:** Combining a flavored liquid with powdered sodium alginate, and then dropping it into a solution of cold calcium chloride to create jelly-like spheres.
- **Transglutaminase:** Also known as "meat glue", this tasteless enzyme can bind protein-rich foods together.

Dehydration: Dehydrating ingredients can intensify their flavors and create new textures. For example, fruits can be dehydrated to create crunchy chips, seasoning, etc...

Liquid Nitrogen: Liquid nitrogen is used in molecular gastronomy to quickly freeze ingredients and create dramatic presentations



A molecular gastronomy dessert served with liquid nitrogen

EPONYMOUS RECIPES

New dishes named after famous scientists include:

Gibbs – Infusing vanilla pods in egg white with sugar, adding olive oil and then microwave cooking. Named after physicist Josiah Willard Gibbs

Vauquelin – Using orange juice or cranberry juice with added sugar when whipping eggs to increase the viscosity and to stabilize the foam, and then microwave cooking. Named after

Nicolas Vauquelin (1763–1829), one of Lavoisier’s teachers.

Baumé – soaking a whole egg for a month in alcohol to create a coagulated egg. Named after the French chemist Antoine Baumé (1728–1804).

OBJECTIVES

The objectives of molecular gastronomy, as defined by Hervé This, are seeking for the mechanisms of culinary transformations and processes (from a chemical and physical point of view) in three areas.

- The social phenomena linked to culinary activity
- The artistic component of culinary activity
- The technical component of culinary activity



Molecular gastronomy includes the study of how different cooking temperatures affect eggs, their viscosity, surface tension, and different ways of introducing air into them

The original fundamental objectives of molecular gastronomy were defined by this in his doctoral dissertation as:

- Investigating culinary and gastronomical proverbs, sayings and old wives' tales
- Exploring existing recipes
- Introducing new tools, ingredients and methods into the kitchen.
- Inventing new dishes.

There are many branches of food science that study different aspects of food, such as safety, microbiology, preservation, chemistry, engineering, and physics. Until the advent of molecular gastronomy, there was no branch dedicated to studying the chemical processes of cooking in the home and in restaurants. Food science has primarily been concerned with industrial food production and, while the disciplines may overlap, they are considered as separate areas of investigation.



spherification of juices and other liquids is a technique of molecular gastronomy

The creation of the discipline of molecular gastronomy was intended to bring together what had previously been fragmented and isolated investigations into the chemical and physical processes of cooking into an organized discipline within food science, to address what the other disciplines within food science either do not cover, or cover in a manner intended for scientists rather than cooks.

Famitha Rassac
Ist MSc. Chemistry

THE ANOMALOUS EXPANSION OF WATER

Water exhibits an unusual behaviour known as anomalous expansion, where it expands instead of contracting as its temperature drops from 4°C to 0°C . This causes its density to decrease as it approaches freezing, with the maximum density occurring at 4°C . This phenomenon arises because, during freezing, water molecules arrange themselves into an open crystalline structure, resulting in a lower density compared to its liquid state. Water is an essential component of all living organisms on Earth, making it a fundamental subject of study in understanding life and biological processes. Its unique molecular structure gives rise to several remarkable and uncommon properties, which play a crucial role in sustaining life and shaping the natural world.

Anomalous expansion of water

Unlike most liquids, which expand when heated and contract when cooled, water exhibits a unique behaviour. Between 0°C and 4°C , water behaves unusually by contracting as it is heated. When water is cooled from room temperature to 4°C , its volume decreases, reaching its maximum density at this temperature. However, as the temperature drops below 4°C , water begins to expand, causing its density to decrease. This distinctive behavior, where water expands as it cools below 4°C , is known as the anomalous expansion of water.



Reason for the Anomalous Expansion of Water

Ice has an "open" crystal structure with significant empty spaces, making it less dense than liquid water. At 0°C , the H_2O molecules begin to lose this open structure as the temperature increases. They form more hydrogen bonds, reducing the intermolecular

distance between the molecules. This reduction in intermolecular distance causes the density of water to increase as the temperature rises from 0°C to 4°C , reaching its maximum at 4°C . However, as the temperature continues to increase beyond 4°C , the kinetic energy of the water molecules rises, causing them to move farther apart, thereby reducing the density.



Consequences and Applications

Weathering of Rocks

Water seeps into the cracks and crevices of granite rocks. During winter, when temperatures drop below 4°C , the water undergoes expansion, exerting hydrostatic pressure on the surrounding rock. This pressure causes the rocks to develop further cracks, accelerating the process of weathering

Preservation of Aquatic Ecosystems in Cold Climates

In cold regions or during winter, the unique property of water known as anomalous expansion plays a crucial role in the survival of aquatic life. When temperatures drop, the surface layer of a water body cools first, and its temperature decreases until it reaches 4°C . At this temperature, water becomes denser and sinks to the bottom, causing a continuous mixing process.

As cooling progresses, a temperature gradient develops, with the lowest layer stabilizing at 4°C . This temperature is ideal for supporting aquatic life. Above this, the temperature gradually decreases with depth, making the topmost layer the coldest. Eventually, the surface freezes, forming an insulating layer of ice.

This ice layer acts as a protective blanket, preventing further heat loss and freezing of the water below. Without this anomalous expansion property, the entire water body could freeze solid, disrupting aquatic ecosystems and halting essential biological processes.

Pipeline Leakage

When temperatures drop below 4°C , some water pipelines may begin to leak due to the pressure created by water's anomalous expansion. Unlike most substances, which contract when cooled and expand when heated, water behaves uniquely. As it cools to 4°C and below, it expands instead of contracting, increasing pressure inside the pipes and potentially causing leaks.

We can now appreciate the critical importance of water's anomalous properties.

Jyolsana Jojo

1st M.Sc Chemistry



INFLUENCE OF ARTIFICIAL INTELLIGENCE ON SCIENTIFIC RESEARCH



Artificial intelligence (AI) has rapidly transformed many industries, and scientific research is no exception. Over the past few decades, AI has increasingly become an indispensable tool in the research process, offering new insights, techniques, and ways of approaching scientific problems.

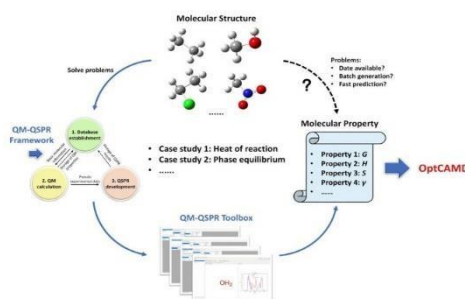
One of the most significant ways in which AI has influenced scientific research is by allowing researchers to analyze and interpret large datasets more efficiently. AI algorithms can quickly process vast amounts of data,

identifying patterns and trends that would be difficult or impossible for humans to detect. This capability has transformed many fields, including genomics, proteomics, and neuroscience. The influence of AI on the field of chemistry has also been substantial. That include the following

1. Molecule property prediction

The prediction of

molecular properties can also be done using machine learning algorithms. These algorithms have been used to predict properties such as bioactivity, toxicity, solubility, melting points, atomization energies, HOMO/LUMO molecular orbital energies and many other kinds of properties. They are neither based on physical laws nor on manually crafted empirical relationships: they are entirely data-driven. Basically,



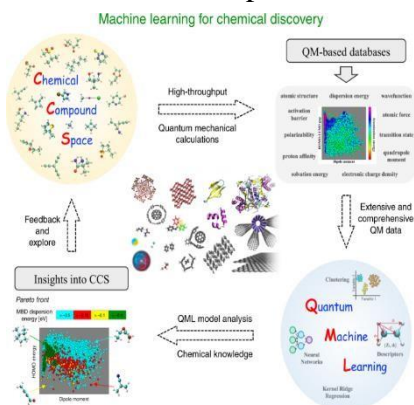
these AI algorithms are trained by feeding them many examples of molecules and their associated properties (supervised learning).

2. Molecule design

Designing new molecules is one of the highest value-added tasks that chemists perform. They usually use

their chemistry knowledge, their domain knowledge and their creativity to propose new molecular structures that are then tested either virtually (in silico) or experimentally in the relevant applications. After the deep learning algorithm has been trained, it can generate large numbers of new molecules by sampling the learned statistical distribution, generally near molecules of interest (eg. molecules that are known to possess desired properties). Then, the designed molecules can either be synthesized or used for virtual screening, (eg. with docking software or AI-based software) to predict their

properties and select only the more interesting ones for further development.



3. Retrosynthesis

There have been many attempts at using computer programs for doing retrosynthesis in the last decades, but these computer-assisted approaches have yielded retrosynthesis of lower quality than the ones that are done by expert chemists.

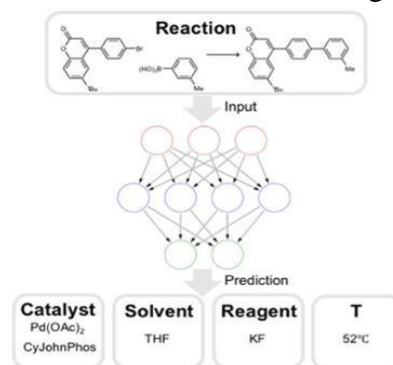
However, recently, several high-performance machine learning-based algorithms have been developed to assist chemists doing retrosynthesis. These complex deep learning algorithms have been trained on very large numbers of organic reactions, typically

millions or tens of millions. The user inputs the molecule that he/she wants to synthesize into the program, and the machine learning algorithm generates a retrosynthesis tree: each node of the tree is a synthesis intermediate and each leaf of the tree is a commercially available starting material

4. Reaction outcome prediction

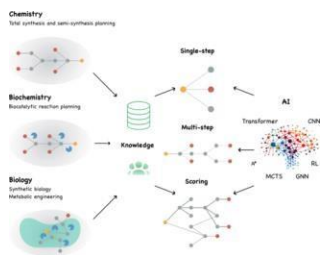
When you have identified the molecule that you want to synthesize and done its retrosynthesis (eg. by using an AI-based retrosynthesis program, as described in the part above), you may want to validate that each one of the synthesis steps is actually feasible.

To do that, you could use AI. Machine learning



programs have been trained with databases of millions of organic reactions to predict reaction outcomes. These programs are based on graph-convolutional neural networks or recurrent neural networks. They work the following way: the reactants are given to the program, and the program predicts the main reaction product and several other possible products, which are often byproducts of the reaction

5. Reaction condition prediction



Once you have identified a reaction that you want to run, you still have to find suitable reaction conditions (solvent(s), catalyst, reagent(s), temperature, concentrations, reaction time,

purification method). You can make a first guess by using your experience and intuition, and you can also search in the literature for similar reactions and use the same conditions for your first synthesis attempts in the laboratory. But first guesses often don't yield the expected results, and finding the conditions that give a high product yield can take dozens or hundreds of experiments. This program does a pretty good job predicting solvent(s), catalyst, reagent(s) and the temperature. One small limitation of that particular program is that it doesn't predict concentrations and reaction times. In the field of genomics, AI has helped to accelerate the pace of research by enabling researchers to analyze and interpret vast amounts of genetic data. This has led to

the discovery of new genes, insights into the molecular mechanisms of disease, and the development of more



effective diagnostic tools and treatments. In neuroscience, AI has been used to analyze complex brain data, leading to a better understanding of brain function and new insights into neurological disorders.

Another way in which AI has influenced scientific research is by facilitating the development of new experimental techniques. For example, in materials science, AI has enabled the rapid screening of large libraries of potential materials, leading to the discovery of new materials with unique properties.

Similarly, in drug discovery, AI has been used to design new compounds and predict their properties, significantly accelerating the drug discovery process. AI has also facilitated interdisciplinary research by enabling researchers from different fields to collaborate more effectively. For example, AI has been used to integrate data from multiple sources, such as genetics, proteomics, and imaging, leading to new insights



into complex biological processes. In addition, AI has enabled researchers from different fields to communicate more effectively, as AI algorithms can translate technical jargon into plain language, facilitating interdisciplinary collaboration.

Dr. Jobi K V
Assistant Professor

WHY ARE WE CELEBRATING NATIONAL SCIENCE DAY?

National Science Day, celebrated annually on February 28, is a tribute to India's scientific achievements, marking the discovery of the Raman Effect by Nobel laureate Sir C.V. Raman in 1928. This discovery, which laid the foundation for advancements in physics, resonates as a powerful symbol of India's commitment to science and innovation.

On this day, we honor the dedication and ground breaking contributions of scientists, researchers, and innovators who have transformed our society and our world.

The Power of Science in Shaping Lives

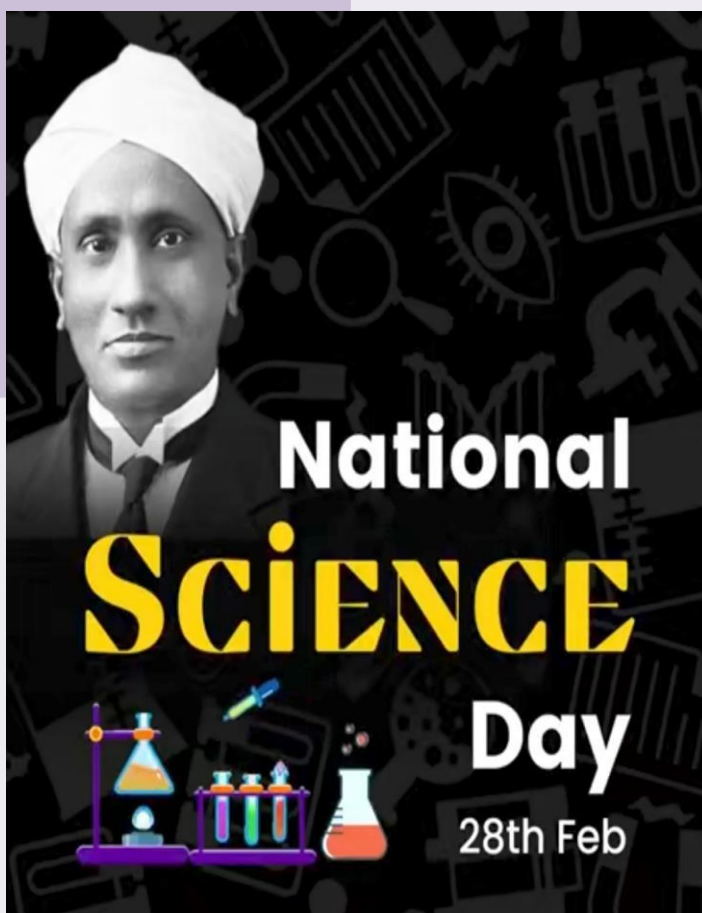
Science has been the driving force behind human progress, improving lives, and reshaping our future. From life-saving medicines to sustainable energy solutions, scientific breakthroughs have allowed us to tackle challenges once we thought it would be

insurmountable. Today, science continues to expand its horizons, exploring cutting-edge fields like space exploration, artificial intelligence, and biotechnology. National Science Day is a celebration of this unyielding spirit of inquiry and invention.

Inspiring the Next Generation of Scientists and

At the heart of National Science Day lies the vision of inspiring future generations to pursue

careers in science, technology, engineering, and mathematics (STEM). This day encourages young minds to ask questions, seek answers, and cultivate critical thinking skills. By fostering a culture of curiosity and innovation, we empower youth to address pressing global challenges, including climate change, healthcare, and energy security. Nurturing this scientific curiosity not only builds individual careers but also strengthens our nation's potential to drive



progress and contribute globally.

Celebrating the Role of Basic Research

Basic research forms the backbone of scientific discovery, often leading to revolutionary breakthroughs and Nobel Prizes. India's scientific community has made significant strides, from pioneering work in space research to rapid advancements in vaccine development. National Science Day serves as a reminder of the value of research at every level and the importance of a supportive ecosystem for scientists to thrive.

Commemorative Events across India

To honor this special day, schools, colleges, and research institutions organize an array of educational and engaging events,

such as:

- Science fairs and exhibitions
- Workshops and expert lectures
- Hands-on experiments and demonstrations
- Competitions and quizzes

These activities not only make science accessible but also stimulate interest and foster collaboration among students, teachers, and scientists, building a robust community of lifelong learners and innovator.

National Science day 2024

The theme for National Science Day 2024, "Indigenous Technologies for Viksit Bharat", highlights the essential role of locally developed technologies in India's progress and self-reliance. This theme underscores the significance of

indigenous innovations, celebrating India's unique scientific identity and contribution to global knowledge.

“The Science of Today is the Technology of Tomorrow”- Edward Teller

National Science Day is not only a celebration of past achievements but a call to action for future innovation. It reminds us that science is a journey—one that requires curiosity, dedication, and a relentless pursuit of knowledge. As we look to the future, let us commit to fostering a scientific community that thrives on discovery and innovation, propelling India towards a "Viksit Bharat" empowered by indigenous technology and resilient scientific growth.

Devika Lathish

IIIrd B.Sc Chemistry



CHEMICAL WASTE MANAGEMENT

Chemical waste management is a critical aspect of environmental protection and public health. Proper management of chemical waste involves several key strategies to minimize its impact on the environment and human health. Here are some important points:

UNDERSTANDING CHEMICAL WASTE

Chemical waste includes any waste material that is hazardous due to its chemical properties. This can include industrial by-products, laboratory waste, and household chemicals. Improper disposal of these substances can lead to soil, water, and air contamination, posing significant risks to ecosystems and human health.

DISPOSAL METHODS

There are various methods for disposing of chemical waste, each with its own advantages and challenges:

- **Incineration:** This method involves burning chemical waste at high temperatures to reduce its volume and toxicity. However, it can release harmful emissions if not properly managed.
- **Landfilling:** Hazardous waste can be contained in specially designed landfills to prevent leaching into the environment. This method requires careful monitoring to avoid contamination.
- **Recycling and Reuse:** Some chemical wastes can be treated and reused, reducing the need for new raw materials and minimizing waste.



SUSTAINABLE PRACTICES

Adopting sustainable practices in chemical waste management is essential for long-term environmental health:

- **Resource Conservation:** Efficient use of resources and minimizing waste generation are crucial. This includes reducing excess consumption and promoting responsible resource management.
- **Circular Economy:** Implementing a circular economy model where waste is minimized, and materials are reused and recycled can significantly reduce the environmental footprint.
- **Compliance with Regulations:** Adhering to local, national, and international regulations ensures that chemical waste is managed responsibly and legally.

HEALTH AND ENVIRONMENTAL IMPACT

Improper chemical waste disposal can lead to severe health issues, including respiratory problems, congenital

disabilities, and cancer. It can also cause long-term damage to ecosystems, affecting biodiversity and natural resources.



FUTURE DIRECTIONS

The future of chemical waste management lies in developing advanced treatment technologies and promoting eco-friendly disposal methods. Innovations in waste-to-energy conversion and sustainable treatment processes are essential for reducing the environmental impact of chemical waste.

Mebin sabu

IIIrd BSc. Chemistry

THE FUTURE OF BIOPLASTIC: A SUSTAINABLE ALTERNATIVE




Bio-plastics are emerging as a promising alternative to traditional petroleum-based plastics. These are a type of plastic materials that is either derived from a renewable biological source such as vegetable fats & oil, corn starch, sawdust, rice starch, etc. or designed to be biodegradable.

WHAT WE CAN EXPECT IN THEIR FUTURE?

- 🌱 **Reduced Environmental Impact:** Environmental footprint. They are often derived from renewable biomass sources such as corn starch, sugarcane, and cellulose. By shifting away from fossil fuel resources, bio-plastics contribute to lowering their overall carbon footprint. : Future bio-plastics will resemble traditional plastics but with a significantly reduced
- 🌱 **Transition to Non-Food Crops:** Currently, some bio-plastics are made from edible first-generation biomass (like corn). However, the industry plans to transition toward using non-food crops.
- 🌱 **Efficient Use of Second-Generation Bio-wastes:** As the field evolves, more efficient methods for utilizing second-generation bio-wastes (such as agricultural residues and forestry byproducts) will be developed.
- 🌱 **Industry Growth:** While bio-plastics currently constitute less than 1% of the traditional plastics market, their global growth potential is substantial. Between 2013 and 2017, bio-plastics saw a growth rate of 29%.

IMPROVING BIOPLASTIC & RECYCLING IS CRUCIAL FOR A MORE SUSTAINABLE FUTURE.

 **Applications across Industries:** The future of bio-plastics extends beyond niche applications. They can replace traditional plastics in various sectors, including packaging, automotive components, and consumer products.

Optimize Recycling Routes

- **Alcoholysis:** This process involves breaking down bio-plastics using alcohol as a solvent.
- **Biodegradation:** Enhancing the natural biodegradability of bio-plastics is essential.
- **Biological Recycling:** Utilizing microorganisms or enzymes to break down bio-plastics.

Invest in Research and Development

Scientists are continually exploring new ways to improve bio-plastic properties, recyclability, and end-of-life options.

Standardize Labeling and Sorting:

- Clear labelling helps consumers identify bio-plastics. Standardized symbols can guide proper disposal and sorting.
- Improved sorting systems at recycling facilities can separate bio-plastics effectively, preventing contamination with conventional plastics.

Educate Consumers and Businesses:

- Raise awareness about bio-plastics and their recyclability. Educate consumers on proper disposal methods.
- Encourage businesses to adopt bio-plastics and implement sustainable practices.

CHALLENGES FACED BY BIOPLASTICS

- ❖ **COST CHALLENGES:** Bio-plastics often have higher production cost compared to traditional petroleum-based plastics.
- ❖ **WATER USAGE:** The cultivation of raw materials for bio-plastics requires significant water resources.
- ❖ **COMPOSTING AND RECYCLING INFRASTRUCTURE:** Effective disposal of bio-plastics relies on proper facilities for composting and anaerobic digestion. Without adequate infrastructure, their end-of-life management becomes challenging.
- ❖ **LIMITED AVAILABILITY:** Bio-plastics are still relatively scarce compared to conventional plastics.
- ❖ **RAW MATERIAL COMPETITION:** Some bio-plastics rely on food crops (e.g., corn), raising concerns about competition with food supplies.

The future of bioplastics lies at the intersection of innovation, policy and consumer demand. While bioplastics offer a promising solution to the plastic pollution crisis, their widespread adoption will require addressing the challenges of cost, waste management, and environmental impact. As technology advances and infrastructure improves, bioplastic could play a vital role in creating a more sustainable and circular economy.

Anakha Binu
IInd MSc. Chemistry

THE ALCHEMY OF FRAGRANCE

“CRAFTING SCENTS THROUGH SCIENCE”

“A good fragrance is a powerful cocktail of memories and emotions”



Perfumes are not new inventions but had been evolved with humans. Although perfume was formulated using plants and flowers before oil was added during ancient times, it resembles how chemistry was studied and applied centuries ago.

The Egyptians were famous for producing perfumes. Initially, liquid perfumes used to be a mixture of oils and

crushed herbs. Then, a renowned physician, Al-Shaykh al-Rais, refined and developed perfume. He is the first one to experiment perfumes with roses and also invented the distillation technique of roses and other plant fragrances. He is the first one to experiment with perfumes with roses.

One of the major processes of perfume making is distillation. Distillation is a technique of capturing essential oil from flowers or plants using water vapor.



However, not all raw materials in perfumery can be treated with distillation. There are also other methods such as maceration & enfleurage. Enfleurage is a two-step process of drawing a fragrance into a fat or oil base and then extracting it with alcohol.

Maceration is a method similar to extraction, where essential oils found in certain types of flowers are extracted to be used in fragrances. Essential oils are extracted by soaking the flowers in water, oil or solvent.

The fragrance industry employs a wide range of chemical processes and often has to deal with complex mixtures of structurally complex material.

Have you ever wondered what makes your favorite fragrance linger in air, evoking memories and emotions with every breath?



The main ingredients of a perfume are ethyl alcohol and essential oils. The concentration of essential oils such as agarwood, sandalwood, and cedarwood, determines how long it can last on your skin. A solid perfume has 20-30% essential oil, EDP has 8-15%, and EDT has 4-8% essential oil. The remaining portion is ethyl alcohol. Descriptions such as EDP and EDT identify the oil concentration in a fragrance composition.

Your body's unique chemistry significantly influences how fragrances perform.

Each individual has different body chemistry. For instance, every person has a different body odour. Fragrance usually lasts longer on moist skin than dry skin, which is why there is summer and winter perfume. It is usually recommended to apply perfume on pulse points because these are the locations on the body where the blood vessels are closest to the skin. The heat generated from the pulse points helps to diffuse, magnify and amplify a scent. Another factor that determines the fragrance's longevity is the perfume molecule. As we know humans are made up of cells and perfumes are made up of molecules. The size of molecules and smell are correlated because the size of the molecule determines how fast they oxidize. The smaller molecules like light citrus aroma oxidizes quickly.

For instance, the musk molecule is complex and has many more electrons to give away before it disappears. The molecules of some synthetic musk are so large and complex that they can last days on your skin.

Do you know that, Bright sunlight can destroy your perfume within a week!!!

Although perfume was widely used from ancient times until the mid-19th century, only wealthy people could afford perfumes as the prices were dictated by their costly ingredients. All thanks to chemists who made perfume affordable for everyone today.



Chemical reactions caused by light can also morph the smell of your

perfume. This is because the energy in light can break the bonds in fragrance molecules. Air can also corrode fragrance by oxidation which is the same process that turns uncorked wine into vinegar. With this being said, the best place to keep your perfume is in a dark room at room temperature in a spray bottle. The best place for application of perfume is on the pulse points. This is because the pulse will warm the perfume and cause it to spread its scent consistently. Again this would not be possible

without the alcohol water mixture and different notes.



Fragrance chemistry is an exciting and challenging field, where scientific, artistic and commercial skills must all be practiced together at the highest level of each.

Perfume chemistry is a captivating field that combines artistry, scientific knowledge, and a keen sense of smell.

The intricate blend of aromatic compounds, solvents, and fixatives results in the enchanting fragrances we cherish. Understanding the chemistry behind perfumes allows us to appreciate the creativity in creating these scented masterpieces.

So the next time you spritz on your favourite perfume, take a moment to ponder the captivating chemistry that dances on your skin and captivating the world around you...

Varsha V

IInd M.Sc Chemistry

CAREER PATH FOR CHEMISTRY GRADUATES IN OUR COUNTRY



One of the major challenges our country faces today is the migration of students to foreign countries for education and employment. Traditional courses, such as degrees in science, are often



overlooked, with many claiming it is difficult to secure a job after graduation. However, this perception does not reflect reality, as there are plenty of job opportunities available within our country. As a postgraduate student in chemistry, I would like to highlight some of the promising career opportunities for chemistry graduates and postgraduates.

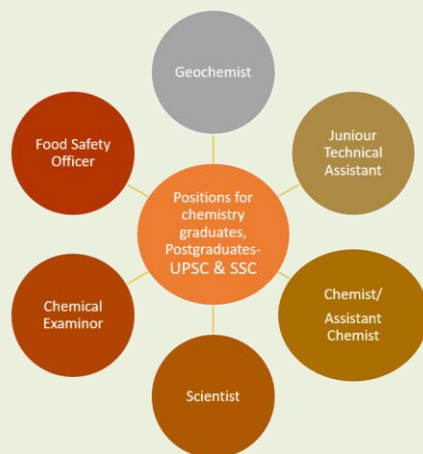
Studying chemistry offers numerous career opportunities in both the private and government sectors. Apart from general positions open to all graduates, there are numerous job opportunities for chemistry graduates with B.Sc, M.Sc, or Ph.D. qualifications in our state through the Kerala Public Service Commission, in our country through SSC, UPSC and in private sector.

The Kerala Public Service Commission (KPSC) offers various career opportunities for chemistry graduates at different educational levels. For those with a Bachelor of Science (B.Sc) in Chemistry, positions such as Quality Analyst and Junior Biochemist etc. Master of Science (M.Sc) graduates can pursue roles including Junior Chemist in the Department of Mining & Geology etc. Additionally, Ph.D. holders in Chemistry may find opportunities in research and development sectors within government organizations. So it's advisable to regularly check the official KPSC website for the latest notifications and application procedures.



Chemistry graduates have excellent opportunities in both **the Union Public Service Commission (UPSC) and the Staff Selection Commission (SSC)**.

Through UPSC, they can apply for roles like Scientific Officer, Chemist in Geological Survey of India, or positions in various ministries and departments as technical experts or analysts. In SSC, chemistry graduates can secure positions such as Junior Chemist, Laboratory Assistant, or Technical Assistant in departments like Food Safety, Environmental Studies, or Agriculture. Additionally, roles in government research laboratories, forensic departments, and quality control divisions are often available, providing a wide range of career paths for graduates.



Chemistry graduates and postgraduates have a wide range of job opportunities in the **private sector**. Industries such as pharmaceuticals, petrochemicals, food and beverages, cosmetics, and materials science actively seek skilled professionals for roles in research and development, quality control, production, and technical support. They can work as analytical chemists, formulation scientists, or quality assurance specialists, ensuring product safety and compliance with standards. Additionally, sectors like biotechnology and environmental consulting offer roles in laboratory analysis, process optimization, and sustainable product development.

Careers in research and development for chemists are primarily found in the **industrial sector**, where companies rely on experts to create new products or improve existing ones. Activities in this field typically encompass two key phases: applied research and product development. In applied research, industrial scientists focus on modifying, combining, and formulating compounds for specific applications to meet business objectives, such as enhancing product flavor to boost sales or extending shelf life to reduce costs. Once a viable solution is identified, the process moves to product development, where the goal is to refine the solution into an effective, safe, and appealing product that can be manufactured efficiently and economically.

In conclusion, I would like to emphasize that there is no need to migrate to other countries or hesitate in choosing basic sciences for higher studies, as there are ample opportunities and promising career prospects available here.

Fathima Bincy V K
Ist M.Sc Chemistry

LIFE WITHOUT CHEMISTRY: AN IMPOSSIBLE CONCEPT

Chemistry is often described as the central science, bridging the gap between physics and biology. It plays a crucial role in understanding the composition, structure, and properties of matter. When considering the question of whether life without chemistry is possible, one quickly realizes that the answer is a resounding no. Life, as we know it, is inextricably linked to chemical processes that govern everything from the molecular level to complex ecosystems.

**Can you imagine a world without
Chemistry?
Answer is “NO”**

The Foundations of Life

At the most fundamental level, life is composed of atoms and molecules. The basic building blocks of life—proteins, lipids, carbohydrates, and nucleic acids—are all formed through chemical bonds and reactions. For instance, proteins, which are essential for virtually every function in living organisms, are composed of amino acids linked together by peptide bonds, a process defined by chemical principles. Without chemistry, the formation and function of these molecules would be impossible.

Metabolism and Energy Transfer

Metabolism, the sum of all chemical reactions that occur within a living organism, is vital for sustaining life. It involves catabolic pathways that break down molecules to release energy and anabolic pathways that synthesize the compounds necessary for growth and repair. Cellular respiration, for example, converts glucose and oxygen into carbon dioxide, water, and energy in the form of ATP—an intricate series of chemical reactions that power all cellular activities. Without these chemical processes, organisms would lack the energy required for survival.

Homeostasis and Regulation

Living organisms maintain homeostasis—an internal balance—through various chemical mechanisms. Hormones, which are chemical messengers, regulate physiological processes such as growth, metabolism, and response to stress. The delicate interplay of chemicals within the body ensures that systems function optimally. Disruptions to these chemical processes can lead to diseases and dysfunction, further emphasizing the essential role of chemistry in life.

The Environment and Ecosystems

Beyond individual organisms, chemistry is vital in understanding ecosystems. Each and every minute processes occurring in the nature can be explained on the language of chemistry. Nutrient cycles, such as the nitrogen cycle and the carbon cycle, rely on chemical transformations that sustain life on earth. These cycles involve the interaction of various organisms, including plants, animals, and microorganisms, all participating in chemical processes that support life. Thus without chemistry, ecosystems would collapse, and life would cease to exist.

Concluding, life without chemistry is not merely improbable; it is fundamentally impossible. Every aspect of life, from the molecular structures that form cells to the complex interactions within ecosystems, is governed by chemical principles. Understanding chemistry not only deepens our appreciation of the natural world but also highlights the intricate connections that sustain life. As we explore the universe, the importance of chemistry as the foundation of life remains clear: it is the language through which nature communicates, and without it, life as we know it would not exist.

Without chemistry, we'd be stuck in the Stone Age. Unleash the little scientist within you for a better life.

All biological processes are rooted in chemical reactions. Everything from digestion to respiration relies on chemical interactions. Even the structure of cells and function of proteins and enzymes are fundamentally chemical in nature. Chemistry is essential for the existence and functioning of life.

Shifna Fathima

Ist MSc. Chemistry



Chemistry of Art Preservation

The arts have long been a cornerstone of human expression, conveying emotions, ideas, and values across generations. However, the passage of time, environmental factors, and human actions can imperil these precious cultural artifacts, threatening to erase our shared history and heritage. Conservation and preservation play a critical role in safeguarding our artistic treasures, ensuring their accessibility and integrity for future generations. By harnessing cutting-edge scientific techniques, collaborative research, and innovative technologies, conservators and preservationists work tirelessly to protect, restore, and conserve paintings, sculptures, textiles, and other cultural artifacts.

Art conservationists use chemical techniques and laboratory equipment, such as X-rays and microscopes, to protect and restore artworks. The practice of restoring historical works has centuries; however, constantly evolving. conservation restoring artworks state, but by the systematic approach encouraged a more different treatments.



Modern conservators aim to study artworks in an environmentally friendly, non-invasive way, as old art can be very fragile. To eliminate traditional destructive techniques, conservators use infrared imaging to examine artworks and detect loss of paint and hidden details under the upper layer of the artwork. The nature and

material used in the artworks also determine their restoration process. Using Raman microscopy, monochromatic light impinges on the material surface and is transmitted or reflected, with the measured frequency of the wavelength of light demonstrating the varnish characteristics. For the variety of varnishes, different organic solvents can be utilized to move the discoloured layers; however, water is the most common solvent, which may be mixed with chelating agents, surfactants, or salt to control the pH.

Artists also tended to paint directly onto wet calcium hydroxide plaster, which reacts with atmospheric carbon dioxide to form calcite or calcium carbonate. For frescoes and plaster-based wall paintings, pollution, and humidity over time will cause the carbonate layer to break down, and salts within the walls will recrystallize, leading to deterioration of the painted surface. Baglioni's treatment injects calcium hydroxide nanoparticles. These tiny particles, of 10–100 nm, are dispersed in alcohol, which allows them to penetrate the frescoes and slowly reform the depleted calcite. Chemistry plays a crucial role in this process.



Synthetic polymers were used to consolidate and stabilize frescoes; however, scientists later discovered their presence could dramatically change the paintings' surface properties. These polymers caused mechanical stresses and the crystallization of salts beneath the painting, lead to accelerated disintegration. Thus, evolving knowledge is essential to discover new ways of art preservation and restoration, as protecting ancient artworks is essential for the study of human civilizations.

With the help of scientific knowledge, especially in chemistry and biology, conservators and art historians would better understand cultural objects without damaging these precious historical relics while also protecting themselves from harmful chemicals.

Atheena Aravind
Ist M.Sc Chemistry

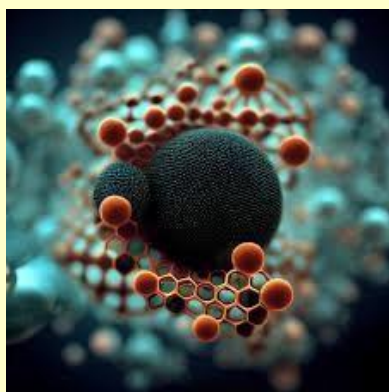
NANOCHEMISTRY: PIONEERING THE FUTURE OF MEDICINE

"Nanotechnology in medicine is going to have a major impact on the survival of the human race"
Bernard Marcus



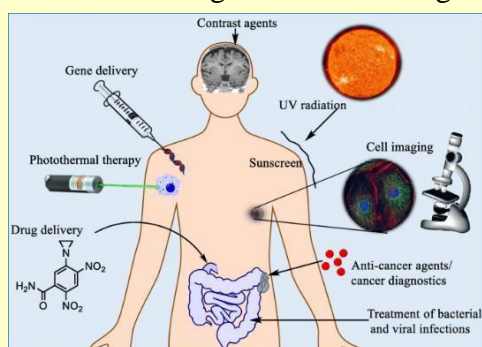
Nanoparticles are small, minute materials with unique physical and chemical properties that range in size from 1 to 100 nanometers in diameter that have revolutionized the medical field. These nanoparticles have a large surface area relative to their volume, leading to enhanced reactivity, optical properties, and the ability to interact more efficiently at a cellular and molecular level. Their applications in the medical field include drug delivery systems, diagnostic imaging, cancer treatment and therapy, regenerative medicine and tissue engineering, antimicrobial and antibacterial applications, gene therapy, biosensors and diagnostic tools, vaccines and immunotherapy, and vaccines and immunotherapy.

Drug delivery systems are highly efficient carriers for targeted drug delivery, minimizing side effects and improving therapeutic efficacy. Nanoparticle-based drug delivery systems can be engineered with surface modifications like ligands, antibodies, or peptides that recognize and bind to specific cellular receptors found on diseased cells, such as cancer cells. Liposomes, dendrimers, and polymeric nanoparticles are widely used for delivering anticancer drugs, antibiotics, and gene therapies. Diagnostic imaging is another area where nanoparticles significantly enhance the capabilities of



various imaging modalities, such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and fluorescence imaging. Their unique optical and magnetic properties allow them to serve as contrast agents, providing more precise and high-resolution imaging. Regenerative medicine and tissue engineering are revolutionizing nanoparticles by supporting the development of scaffolds for tissue repair and regeneration. Nanoparticles can be integrated into biomaterials to enhance their mechanical strength, biocompatibility, and cellular

interactions. Magnetic nanoparticles can also be used to label and track stem cells in vivo, providing real-time information about their migration, proliferation, and differentiation patterns, which are essential for successful tissue regeneration. Antimicrobial and antibacterial applications are another area where nanoparticles play a critical role. Silver and zinc oxide nanoparticles possess strong antimicrobial properties, which can be integrated into coatings for



medical devices, wound dressings, and surgical instruments to prevent infections. This multi-targeted approach makes it difficult for pathogens to develop resistance, unlike traditional antibiotics. Gene therapy offers a promising approach for delivering genetic material, such as DNA or RNA,

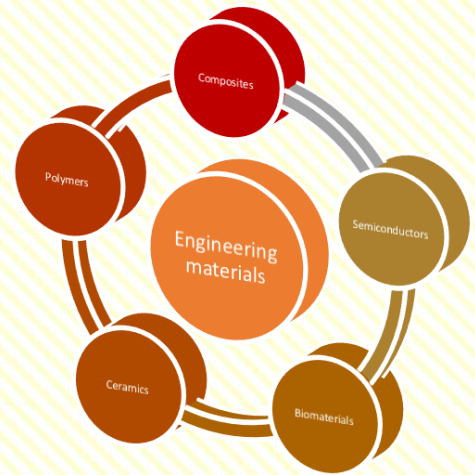
to specific cells. Polymeric nanoparticles and liposomes are widely used as non-viral vectors for gene therapy, offering safety and biocompatibility. Recently, researchers have developed nanoparticles for delivering the CRISPR-Cas9 system for gene editing, which has the potential to correct genetic disorders by precisely targeting and modifying defective genes. Biosensors and diagnostic tools are also playing a critical role in the development of nanoparticles for early detection of diseases. Gold nanoparticles are used in electrochemical biosensors to detect glucose, cholesterol, and cancer markers, while silver nanoparticles are utilized in surface-enhanced Raman scattering (SERS)-based biosensors for detecting pathogens and environmental toxins. Point-of-care testing is being developed for nanoparticle-based diagnostic tools, which enable quick diagnosis of infectious diseases like COVID-19 or malaria. Lipid nanoparticles in mRNA vaccines have been pivotal in the rapid development of COVID-19 vaccines

In conclusion, nanoparticles have the potential to revolutionize conventional medical practices by providing more targeted, efficient, and personalized healthcare solutions. As research progresses, nanoparticles are likely to become an integral part of the future medical landscape, addressing unmet medical needs and improving patient outcomes.

Aswini M O
IInd M.Sc Chemistry

PIONEERING DESIGN AND MATERIAL DISCOVERY

The quest for advanced materials has been at the forefront of scientific research and engineering innovation. As industries demand higher performance, sustainability, and versatility, the design and discovery of new materials—especially polymers, ceramics, and composites—have taken centre stage. This article explores the latest advancements in these three categories, their unique properties, and their potential applications.



Polymers: Versatility Meets Functionality

Polymers are long-chain molecules made up of repeating structural units. They are renowned for their versatility, lightweight properties, and resistance to chemicals. Recent developments in polymer science have led to the creation of smart polymers that respond to environmental stimuli such as temperature, pH, or light.



1. **Biodegradable Polymers:** With growing environmental concerns, researchers are focusing on biodegradable polymers derived from renewable resources. Polylactic acid (PLA) and polyhydroxyalkanoates (PHA) are prime examples that can reduce plastic waste significantly.
2. **Conductive Polymers:** Innovations in conducting polymers have opened doors for applications in flexible electronics, sensors, and energy storage. These materials can be integrated into wearable technology, offering functionality without sacrificing comfort.
3. **Self-Healing Polymers:** Inspired by biological systems, self-healing polymers can automatically repair damage when exposed to certain stimuli. This feature is particularly promising for applications in coatings and structural materials.

Ceramics: Strength and Durability

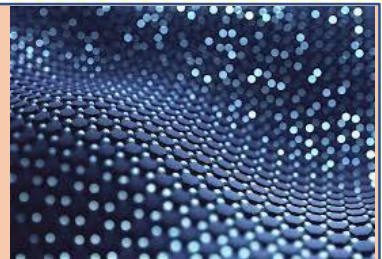
Traditionally known for their brittleness, ceramics have undergone a transformation with advancements in material design and processing techniques. Modern ceramics are now characterized by enhanced toughness, thermal stability, and unique electrical properties.



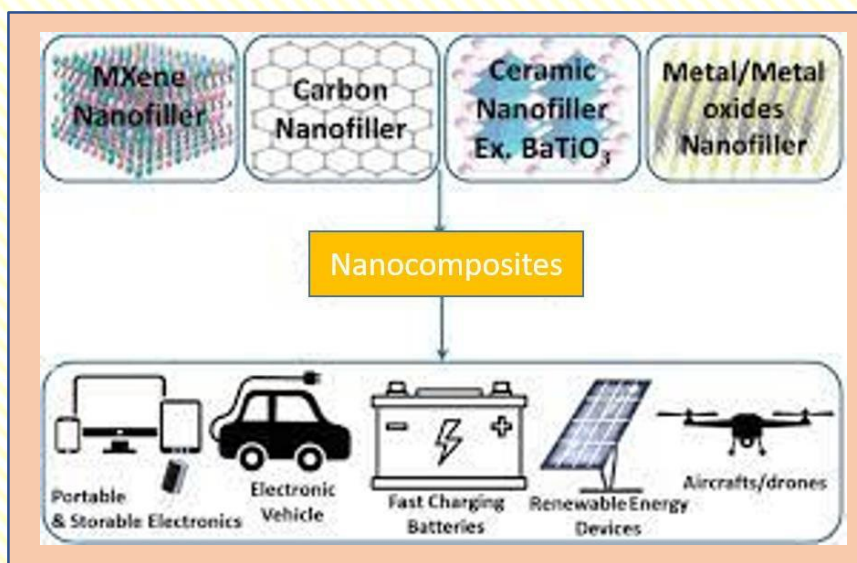
1. **Nano-Ceramics:** The use of nanotechnology in ceramics has led to materials that possess superior strength and resistance to wear. These nano-ceramics are being explored for applications in aerospace, automotive, and biomedical fields.
2. **Bioceramics:** With a focus on medical applications, bioceramics such as hydroxyapatite are used in bone repair and dental applications due to their biocompatibility and ability to promote tissue regeneration.
3. **Electroceramics:** These materials, including piezoelectric and ferroelectric ceramics, are crucial in electronics and energy harvesting. Their ability to convert mechanical energy into electrical energy is paving the way for innovative sensor technologies.

Composites: Combining Strengths

Composites combine two or more materials to create a product with enhanced properties. They are increasingly used in industries such as aerospace, automotive, and construction due to their lightweight and high-strength characteristics.



1. **Carbon Fiber Reinforced Composites:** These materials are renowned for their high strength-to-weight ratio. Advances in manufacturing techniques are making them more affordable and accessible for a wider range of applications, including sporting goods and automotive components.
2. **Bio-Based Composites:** Incorporating natural fibers into composites not only reduces weight but also enhances sustainability. Bio-composites made from hemp, flax, or bamboo fibers are gaining popularity in the automotive and construction sectors.
3. **3D Printed Composites:** The rise of additive manufacturing is enabling the creation of complex composite structures that were previously impossible to fabricate. This technology allows for tailored material properties, optimizing performance for specific applications.



The design and discovery of new materials—polymers, ceramics, and composites—are revolutionizing various industries by offering innovative solutions to modern challenges. As research continues to push the boundaries of material science, we can expect even more breakthroughs that enhance performance, reduce environmental impact, and improve the quality of life. The future of materials is not just about finding new substances; it's about reimagining what those substances can do for society.

Sahala Ilias

IInd M.Sc Chemistry

UNDER THE OZONE'S EMBRACE



The ozone layer, located in the Earth's stratosphere, plays a crucial role in shielding us from harmful ultraviolet (UV) radiation from the sun. This layer absorbs most of the sun's UV radiation, preventing it from reaching the Earth's surface where it can cause skin cancer, cataracts, and harm to marine life. However, human activities have led to the depletion of the ozone layer, primarily due to the release of substances like chlorofluorocarbons (CFCs) and halons,

To combat ozone depletion, international cooperation has been essential. The Montreal Protocol, signed in 1987, is a landmark international agreement aimed at phasing out the production and consumption of ozone-depleting substances. This agreement has been successful in reducing the emission of harmful chemicals, leading to gradual healing of the ozone layer.

Public awareness campaigns have played a vital role in educating people about the importance of protecting the ozone layer and encouraging environmentally friendly practices.

Individual actions also make a significant impact in the protection of Ozone layer. Using eco-friendly products, like aerosols without CFCs, choosing energy efficient appliances, and reducing personal carbon footprint by using public transport or carpooling, all contribute to ozone layer protection. Furthermore, supporting policies that promote sustainable practices and renewable energy sources can further safeguard the ozone layer for future generations. By working together at both the global and individual levels, we can protect the ozone layer and thus by lifes

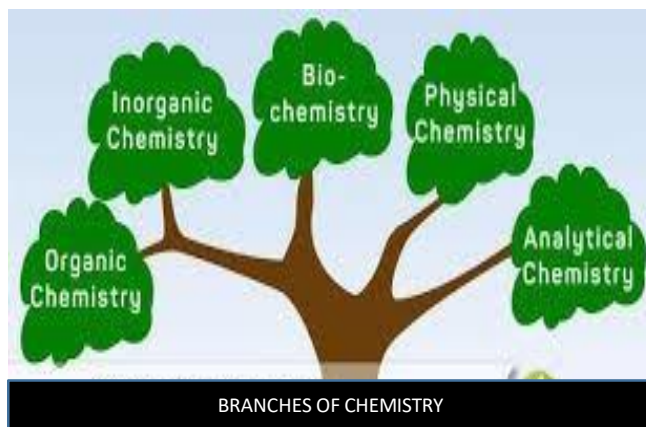
CHIPPI SASI
IIIrd BSc. Chemistry

VARIOUS CLASSIFICATION OF CHEMISTRY

The structured knowledge that humans have gained through observation and experimentation is referred to as science. Owing to its vast scope and diverse topics, science has been subdivided into various branches. One of the most significant fields of science is chemistry.

Chemistry is a sub discipline of science that deals with the study of matter and the substances that constitute it. It also deals with the properties of these substances and the reactions undergone by them to form new substances.

Chemistry primarily focuses on atoms, ions, and molecules which, in turn, make up elements and compounds. These chemical species tend to interact with each other through chemical bonds. It is important to note that the interactions between matter and energy are also studied in the field of chemistry.



BRANCHES OF CHEMISTRY

The five main branches of chemistry are physical chemistry, organic chemistry, inorganic chemistry, analytical chemistry, and biochemistry.

Inorganic Chemistry

The study of compounds that is not organic, such as sodium chloride (NaCl). Inorganic compounds are not based on C-C and C-H bonds.

Organic Chemistry

Organic chemistry is the study of the properties and reactions of compounds that contains carbon atom. It deals with the composition and properties of organic molecules.

Physical Chemistry

Physical chemistry includes the study of the principles underlying chemistry, including the properties of matter, atoms and molecules.

Biochemistry

Biochemistry involves the chemistry in living organism. It includes the structure and functions of their chemical components.

Analytical Chemistry

Analytical chemistry deals with the instrumentations in chemistry. It involves techniques like chromatography, titration, precipitation, spectroscopy etc.

Some other most popular branches of chemistry are:

Environmental Chemistry

It is a study of biochemical processes that occur in the natural environment. Environmental chemistry is a mixture of various subjects such as biology, maths, and toxicology to find out the ways for sustainable development. Environment chemistry is an essential branch of chemistry because it deals with environmental functions.

Industrial Chemistry

Industrial Chemistry is important to manufacture new products. Raw products are dissolved, heated, filtering and various other techniques to form a new product. Examples of industrial chemistry are petrochemicals – ethylene, propylene, benzene, styrene, Ceramic products – silica brick, frit, etc.

Polymer Chemistry

It focuses on polymers and macromolecules. Polymer structures are present in organic chemistry, analytical chemistry, and physical chemistry as well. It can also be included in nanotechnology. It can further be classified into thermoplastics, thermosets, elastomers, and synthetic fibers.

Nuclear Chemistry

As the name implies, it is the study of nuclear reactions. It is vividly used in various treatments and cures. It revolves around radioactivity, nuclear processes, and transformations.

Geochemistry

Geochemistry is an in-depth study of Earth Systems and Environmental Sciences. Geochemistry is important to understand the mineral, weathering agents, and other environmental aspects. Earth is composed to various chemicals and geochemistry is the study of all those chemical processes.

Few other branches of chemistry are

Medical chemistry, Physical organic chemistry, Organometallic chemistry, Bioinorganic chemistry, Solid-state chemistry, Neurochemistry, food chemistry, forensic chemistry, Molecular biochemistry etc.

Khapang Debbarma
Ist B.Sc (Hons.) Chemistry

ASTOUNDING FACTS IN CHEMISTRY

- Blood is not always red some animals have BLUE BLOOD which is due to the Copper containing protein
- MARS is red due the presence of Iron oxide
- When we lost approximately 1% water of our body's then we feel thirsty.
- Lemons have more sugar than strawberries.
- Glass is not solid – it is in fact, a liquid. That's right! However, as the glass molecules flow very slowly, this means they will not shatter or change shape. Often, this state is known as being amorphous (somewhere between the two: a solid and a liquid).



"J" is the only letter which is not found in the periodic table.

- Mixing sufficient quantity of salt into a full glass of water, the water level will go down as salt have a capacity to retain water.
- Fish scales are commonly used as an integral part of lipstick.
- Helium balloons float because helium (also present in all the stars and abundant throughout the universe) is lighter than air. This causes it to float , a slight illusion but yet again, another fun science fact.
- Mixing of equal volume of alcohol and water, the total volume will be decreased as the molecules of ethanol are smaller than water molecules, hence on mixing together, ethanol acquire the spaces left between the water molecules causing a less volume of the solution.
- Your car's airbags are packed with salt sodium azide, which is very toxic. When a collision takes place, the car's sensors trigger an electrical impulse which in the fraction of a second dramatically raises the temperature of the salts. These then decompose into harmless nitrogen gas, rapidly expanding the airbag.

Feba Baburaj
1st B.Sc (Hons.) Chemistry