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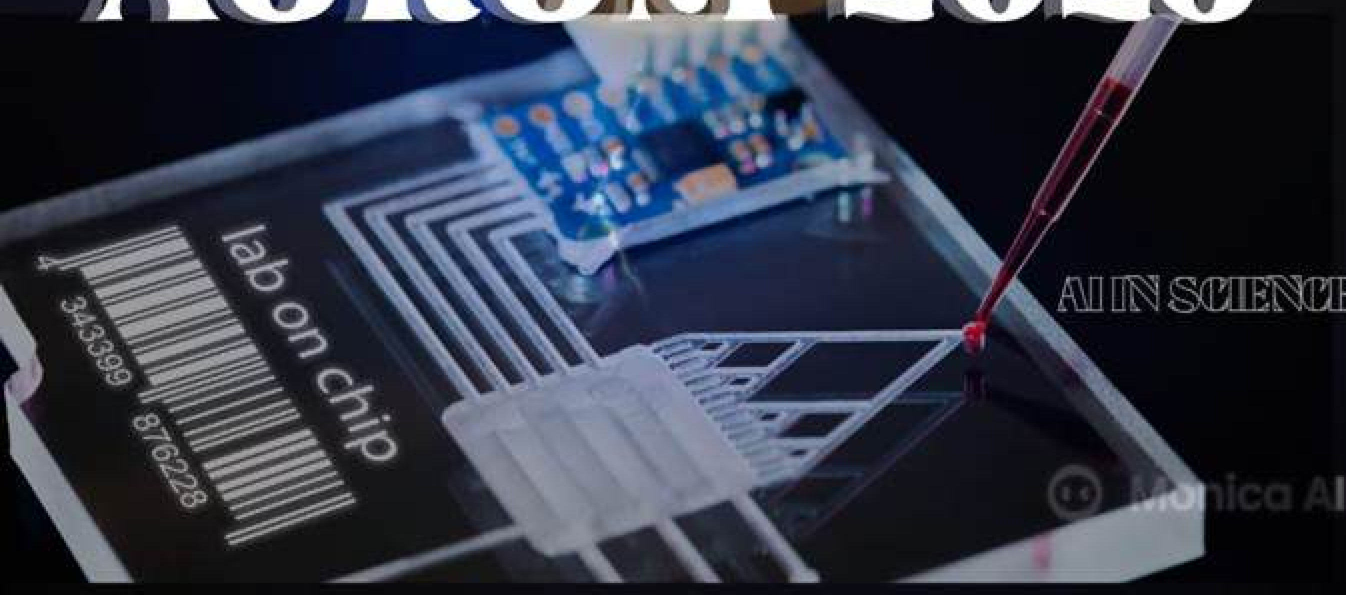
PG AND RESEARCH DEPARTMENT OF CHEMISTRY

NOBEL PRIZE

Presents

AURUM 2025



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POST GRADUATE AND RESEARCH DEPARTMENT OF CHEMISTRY

AURUM 2025

AURUM 2025 - 2026

Post Graduate & RESEARCH DEPARTMENT OF CHEMISTRY

Our Revered Founder

Shri. V. L. Ethiraj

We extend our gratitude to your service for the growth of women in society and made them to be best in life.

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THE EDITORIAL

"Chemistry is necessarily an experimental science: its conclusions are drawn from data, and its principles supported by evidence from facts"

- Michael Faraday.

It gives an immense pleasure for us EDITORIAL BOARD MEMBERS, to release, **"AURUM 2025 - 2026"** – The Annual Chemistry Magazine.

Chemistry, in the year 2025 has been witnessing an amalgamation of traditional research areas, *viz;* - synthesis of compounds, fabrication of new materials, significant data analysis with the new age of Artificial Intelligence (AI). Yet the never-ending urge of Chemists to explore newer synthetic approaches for multidimensional applications does not stop.

The magazine, AURUM 2025 – 2026, showcases the ability of our students of both Undergraduate and Postgraduate Courses in expressing their scientific knowledge and understanding in a unique and creative way. The AURUM 2025 is categorized into four topics with articles focusing on "Nobel Prize in Chemistry", "Role of Chemistry in Climate change", "AI in chemistry" and other "Emerging Chemistry". Some of the interesting topics include "Notes on the Bredt's Rule", "Quality assessment of food using AI tools", "Significance of chemistry in the formulation of life saving Vaccines". The students have also presented a separate section on "Chempuzzles", Fun-filled Riddles, and Crosswords to the readers.

The highlight of the magazine is that all the articles were checked for plagiarism, originality of the communication without the use of ChatGPT and AI by the contributors. Also it has given an opportunity for the students to write research articles of higher order thinking that can be published.

We, the Editorial Board members, express our sincere gratitude to our esteemed Chairman, Thiru. V.M. Muralidharan, beloved Principal and Secretary, Dr. S. Uma Gowrie, Tmt. Beulah Jebakumari Suganthi, Vice Principal (Aided). We also extend our gratitude to Dr. S. Sudhaparimala, Head, PG and Research Department of Chemistry, Faculty members, Alumnae, Sponsors and Krishna Enterprises (Printer) for their support to publish this chemistry magazine, "AURUM 2025 - 2026".

BREAKING BREDT'S RULE AT 100

How Chemists Synthesized the "Impossible" Anti-Bredt Olefins

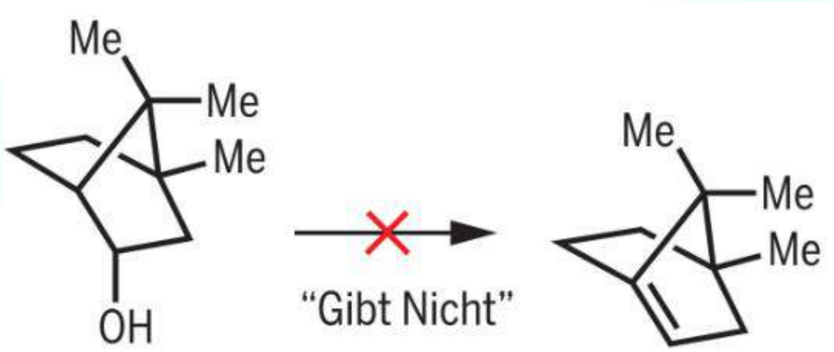
ARCHANAA DEVI V.

II M. Sc.

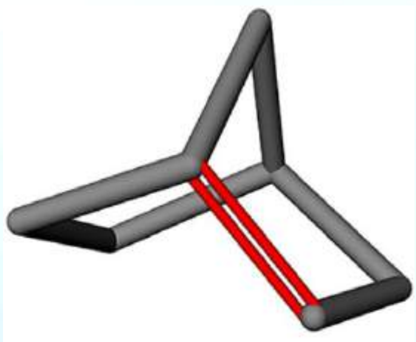
INTRODUCTION

100 YEARS OLD BREDT's RULE HAS BEEN BROKEN

A cornerstone of organic chemistry **since 1924**, Bredt's Rule asserts that double bonds cannot be placed at bridgehead carbons in small bicyclic frameworks due to prohibitive strain and improper orbital alignment. For decades, this rule was treated as inviolable.



Recent research led by Neil K. Garg at UCLA, however, demonstrates that not only can Anti Bredt Olefins (ABOs) exist transiently. But they can also be generated in situ and trapped for synthetic utility – effectively breaking Bredt's Rule. This breakthrough signals a paradigm shift in how we approach strained π systems in synthesis and molecular design.



ANTI-BREDT OLEFIN

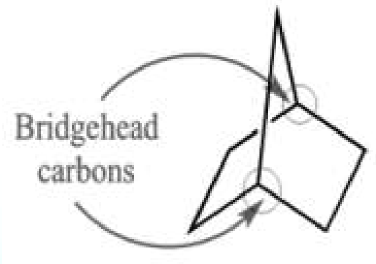
OBJECTIVES

1. Explores the history of Bredt's Rule, including Julius Bredt's original camphor studies and 1924 formulation.
2. Present the novel synthetic strategy developed by Garg's group for accessing ABOs.
3. Analyze reactivity and trapping experiments demonstrating the intermediacy of distorted π bonds.

4. Evaluate the implications of ABO access for future research---impacting chemists, educators, students, and pharmaceutical industries.

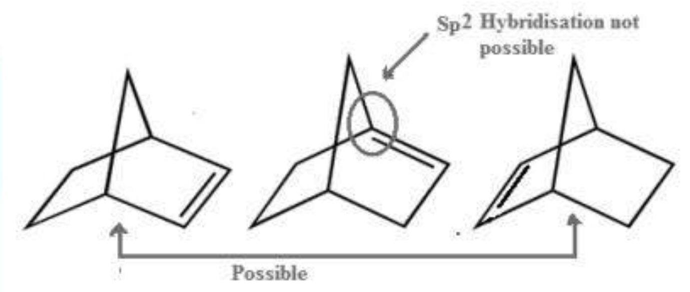
HISTORICAL FOUNDATION OF BREDT'S RULE

In the early 20th century, Julius bredt attempts to form a bridgehead double bond over the studies of camphor and pinane derivatives were consistently failed due to severe angle strain. In 1924, he codified this as a general empirical rule: bridgehead carbons in small bicyclic systems cannot support double bonds. As a result, textbook versions of the rule equated it to forbidding such alkenes entirely. Early exceptions using harsh methods produced fleeting intermediates, but no general, practical synthetic route existed until recently.



BICYCLO[2.2.1]HEPTANE
[NORBORNANE]

BICYCLO[2.2.1]HEPT-2-ENE
BICYCLO[2.2.1]HEPT-6-ENE



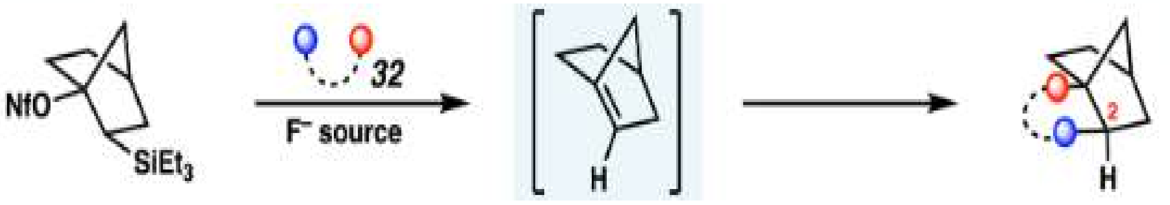
BICYCLO[2.2.1]HEPT-3(4)-ENE

[NORBORNENE]

SYNTHETIC STRATEGY:

Fluoride-Mediated Generation Of ABOs

Garg's team designed silyl (pseudo) halide precursors attached at bridgehead positions inspired from the Kobayashi's methods for mild generation of arynes . Upon treatment with a fluoride source under mild conditions, syn-elimination yields a twisted, geometrically distorted anti-Bredt olefin. Due to its inherent instability, the ABO forms transiently and is immediately trapped by a suitable reagent.

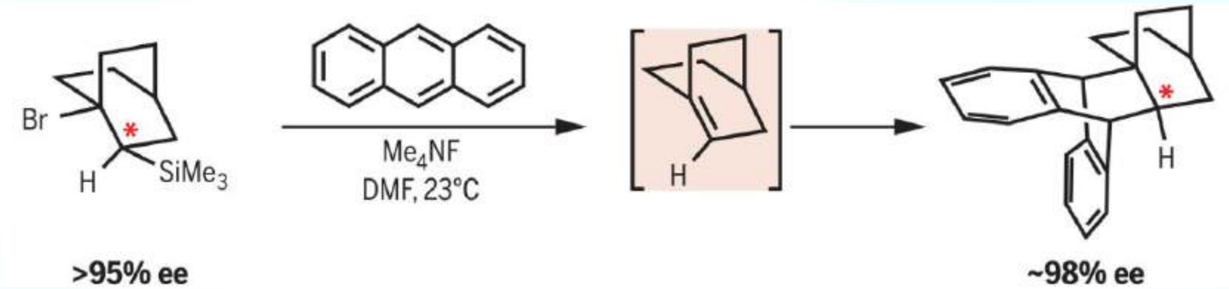


Computational validation using Density Functional Theory (DFT) confirmed that these strained alkenes exhibit substantial twisting and pyramidalization, with diminished p-orbital overlap but distinct olefinic character.

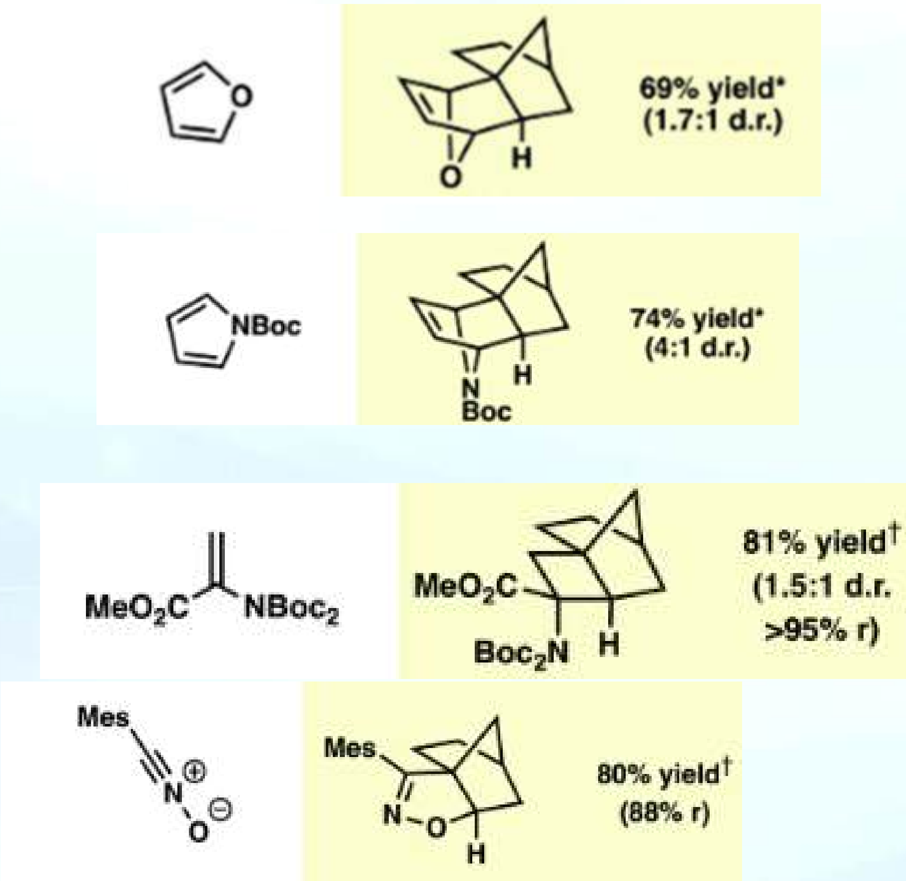
TRAPPING EXPERIMENTS AND REACTION SCOPE

The transient ABO intermediates were intercepted using a variety of cycloaddition partners:

- Anthracene (Diels-Alder, (4+2))



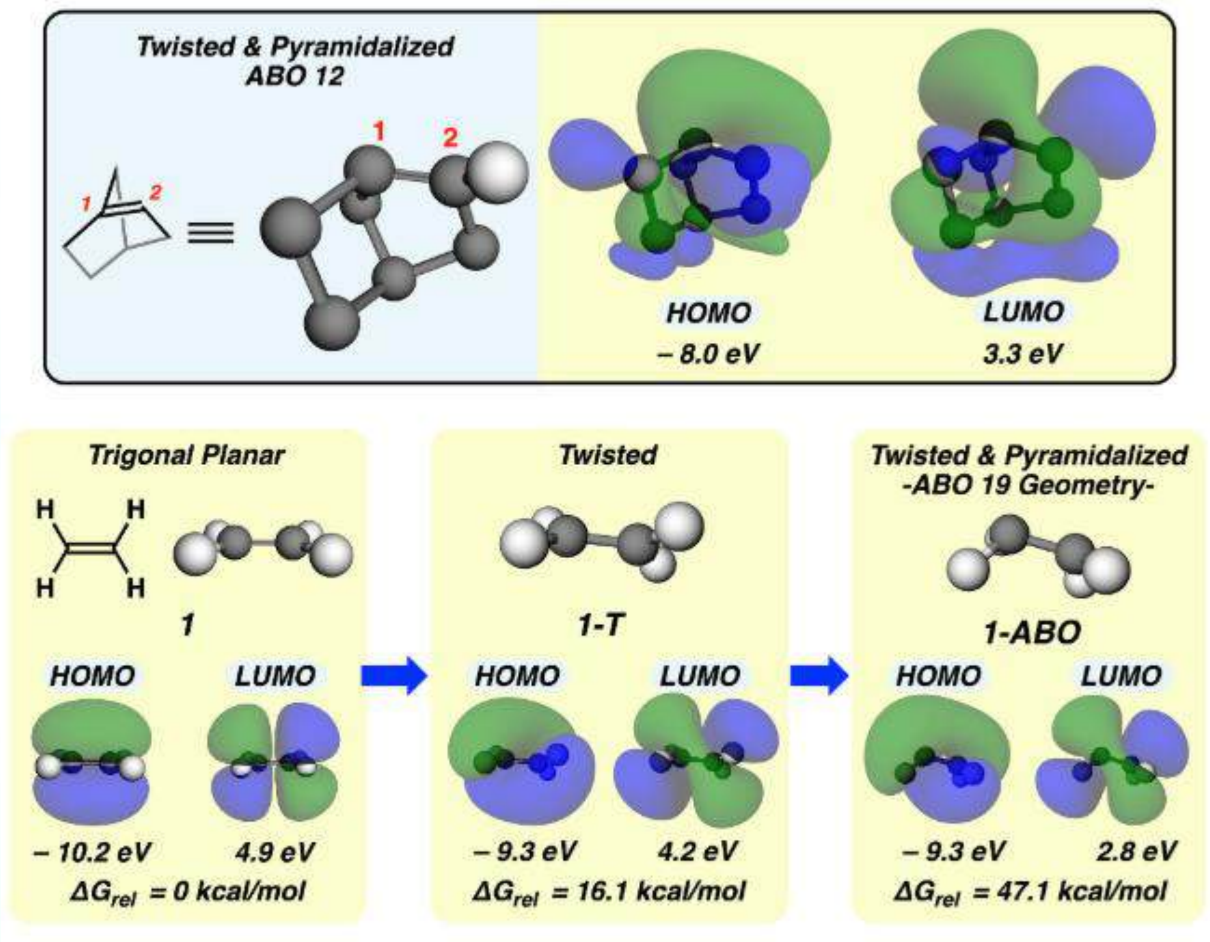
- Furan, 1,3-dipoles, dienophiles ((2+2), (3+2), (5+2))



These experiments yielded structurally complex adducts, demonstrating the synthetic value of ABOs as reactive intermediates. Especially in the [2.2.2] bicyclic ABO, the enabled chirality transfer from precursor to product via an axially chiral intermediate--confirming the olefinic concerted reactivity.

MECHANISTIC INSIGHTS & COMPUTATIONAL INTERPRETATIONS

Mechanistic analysis revealed that elimination demands precise syn geometry-the silyl group and leaving group must align to allow σ → σ* overlap. DFT models showed that only certain diastereomeric precursors could undergo elimination efficiently, explaining why specific stereochemical configurations are reactive.



The computed structures showed pyramidal sp^2–sp^3 hybridization, and calculated bond orders (~1.8) consistent with genuine π-bonds despite distortion.

IMPLICATIONS FOR THE FUTURE OF ORGANIC CHEMISTRY

- For chemists and synthetic designers: Anti-Bredt Olefin represents a new class of highly reactive, 3D molecular scaffolds accessible via mild chemistry.
- For students and educators: Bredt's Rule must now be taught as a guideline, not a fixed law—the example underscores the importance of experimental verification over dogma.
- For pharmaceutical research: The ability to craft conformationally rigid, chiral molecules via ABO-based cycloadditions may enable novel drug scaffolds with enhanced stereochemical complexity.
- For computational chemists: This work highlights how DFT and mechanistic modeling can guide strategic precursor design to access unusual strained intermediates.

CONCLUSION

The work of Garg and colleagues effectively breaks a 100-year-old constraint in organic chemistry: Bredt's Rule is no longer absolute.

- **History revisited**: Bredt's original 1924 findings are placed in context and shown as historically limiting but not inviolable.
- **Novel method realized**: A synthetic strategy using silyl precursors and fluoride promotes controlled generation and trapping of ABOs.
- **Trapping and mechanism**: Cycloaddition outcomes, chirality transfer, and DFT support establish ABO intermediacy and reactivity.
- **Impacts charted**: The research opens new avenues for pedagogy, synthetic strategy, and pharmaceutical design.

This breakthrough underscores a broader lesson: "Rules" in chemistry are best viewed as testable assumptions—not immutable truths. The success in accessing ABOs invites re-examination of other long-held constraints, fostering creativity and innovation across academia and industry.

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NOBEL PRIZE IN CHEMISTRY

NOBEL PRIZE WINNERS IN CHEMISTRY

UDHAYA PRIYA S.

II B. Sc

- The **Nobel Prize in Chemistry** is awarded annually by the Royal Swedish Academy of Sciences to scientists in the various fields of chemistry. It is one of the five Nobel Prizes established by the will of Alfred Nobel in 1895, awarded for outstanding contributions in chemistry, physics, literature, peace, and physiology or medicine.
- The first Nobel Prize in Chemistry was awarded in 1901 to Jacobus Henricus van't Hoff, of the Netherlands, for his discovery of the laws of chemical dynamics and osmotic pressure in solutions. From 1901 to 2024, the award has been bestowed on a total of 195 individuals. The 2024 Nobel Prize in Chemistry was awarded to Demis Hassabis and John Jumper for protein structure prediction and to David Baker for Computational Protein Design.

Nobel prize winners in chemistry


Demis Hassabis


John Jumper

The Nobel Prize in Chemistry 2024 is about proteins, life’s ingenious chemical tools. David Baker has succeeded with the almost impossible feat of building entirely new kinds of proteins. Demis Hassabis and

John Jumper have developed an AI model to solve a 50-year-old problem: predicting proteins' complex structures. These discoveries hold enormous potential.

Some famous Nobel prize winners in chemistry

1.Marie Curie (1911)

She was awarded the Nobel Prize for discovering two elements — radium and polonium — and for her groundbreaking research on radioactivity.

2. Linus Pauling (1954)

He won the prize for figuring out how atoms bond in molecules. His work helped us understand the structure of chemical compounds.

3. Ahmed Zewail (1999)

Zewail used ultra-fast lasers to watch chemical reactions in real time — literally seeing atoms move! This field is now known as femto-chemistry. She developed a way to evolve enzymes in the lab, which helps create better medicines and greener technologies. She was the first American woman to win the Nobel in Chemistry.

5. Emmanuelle Charpentier & Jennifer Doudna (2020)

These two scientists created CRISPR-Cas9 — a tool that can edit DNA. It has completely changed how we think about genetics and treating diseases.

6. Benjamin List & David MacMillan (2021)

They invented a new, eco-friendly way to speed up chemical reactions using small organic molecules — called organocatalysis.

From India to the World

Venkatraman Ramakrishnan (2009)

- He helped uncover how ribosomes (tiny machines in our cells) make proteins. This was a huge breakthrough in biology and medicine.

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https://www.nobelprize.org

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NOBEL PRIZE IN CHEMISTRY 2019

LITHIUM ION BATTERY

B. SREE VARSHINI

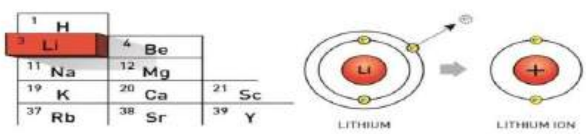
II B.Sc

The Nobel Prize in Chemistry 2019 was awarded to John B. Goodenough, M. Stanley Whittingham and Akira Yoshino for their contributions to the development of the lithium-ion battery. This rechargeable battery laid the foundation of wireless electronics such as mobile phones and laptops. It also makes a fossil fuel-free world possible, as it is used for everything from powering electric cars to storing energy from renewable sources.

They developed the world's most powerful battery

An element rarely gets to play a central role in a drama, but the story of 2019's Nobel Prize in Chemistry has a clear protagonist: lithium, an ancient element that was created during the first minutes of the Big Bang.

Berzelius named the new element after the Greek word for stone, lithos.

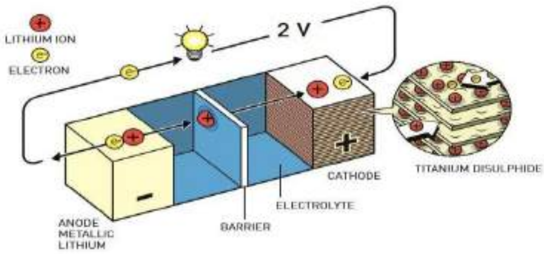


Lithium is a metal. It has just one electron in its outer electron shell, and this has a strong drive to leave lithium for another atom. When this happens, a positively charged – and more stable – lithium ion is formed. Lithium's weakness – its reactivity – is also its strength. In the early 1970s, Stanley Whittingham used lithium's enormous drive to release its outer electron when he developed the first functional lithium battery. In 1980, John Goodenough doubled the battery's potential, creating the right conditions for a vastly more powerful and useful battery. In 1985, Akira Yoshino succeeded in eliminating pure lithium from the battery, instead basing it wholly on lithium ions, which are safer than pure lithium. This made the battery workable in practice. Lithium-ion batteries have brought the greatest benefit to humankind, as they have enabled the development of laptop computers, mobile phones, electric vehicles and the storage of energy generated by solar and wind power. `

We will now step fifty years back in time, to the beginning of the lithium-ion battery's highly charged story.

LITHIUM IN THE NEGATIVE ELECTRODE

Isn't lithium supposed to have pride of place in this story? Well, this is where lithium enters the narrative – as the negative electrode on Stanley Whittingham's innovative battery. Lithium was not a random choice; in a battery, electrons should flow from the negative electrode – the anode – to the positive one – the cathode. The anode should therefore contain a material that easily gives up its electrons, and lithium is one of the elements that most willingly releases an electron.



The result was a rechargeable lithium battery that worked at room temperature and – literally – had great potential.

WHITTINGHAM 's BATTERY

The advantage of Whittingham's lithium battery was that lithium ions were stored in spaces in the titanium disulphide in the cathode. When the battery was used, lithium ions flowed from the lithium in the anode to the titanium disulphide in the cathode. When the battery was charged, the lithium ions flowed back again..

GOODENOUGH's BATTERY:

Goodenough started to use cobalt oxide in the lithium battery's cathode. This almost doubled the battery's potential and made it much more powerful.

Japanese companies want lightweight batteries for new electronics

However, in the West, as oil became cheaper, interest paled in investments in alternative energy technology and the development of electric vehicles. Things were different in Japan; electronics companies were desperate for lightweight, rechargeable batteries that could power innovative electronics, such as video cameras, cordless telephones and computers. One person who saw this need was Akira Yoshino from the Asahi Kasei Corporation.

Yoshino builds the first commercially viable lithium-ion battery

Akira Yoshino developed the first commercially viable lithium-ion battery. He used Goodenough's lithium-cobalt oxide in the cathode and in the anode he used a carbon material, petroleum coke, which can also intercalate lithium ions. The battery's functionality is not based upon any damaging chemical reactions. Instead, the lithium ions flow back and forth between the electrodes, which gives the battery a long life. Another big advantage is that the battery has no pure lithium. In 1986, when Akira Yoshino was testing the battery's safety, he exercised caution and used a facility designed for testing explosive devices. He dropped a large piece of iron on the battery, but nothing happened. However, on repeating the experiment with a battery that contained pure lithium, there was a violent explosion. Passing safety testing was fundamental to the future of the battery. Akira Yoshino says that this was "the moment when the lithium-ion battery was born".

The lithium-ion battery – necessary for a fossil fuel-free sociey

Like almost everything else, the production of lithium-ion batteries have an impact on the environment, but there are also huge environmental benefits. The battery has enabled the development of cleaner energy technologies and electric vehicles, thus contributing to reduced emissions of greenhouse gases and particulate.Through their work, John Goodenough, Stanley Whittingham and Akira Yoshino have created the right conditions for a wireless and fossil fuel-free society, and so brought the greatest benefit to humankind.

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2019 to

JOHN B. GOODENOUGH

Born 1922 in Jena, Germany.

Ph.D. 1952 from the University of

Chicago, USA. Virginia H. Cockrell

Chair in Engineering at The University

of Texas at Austin, USA.

M. STANLEY WHITTINGHAM

Born 1941 in the UK. Ph.D. 1968 from Oxford University, UK. Distinguished Professor at Binghamton University, State University of New York, USA.

AKIRA YOSHINO

Born 1948 in Suita, Japan.

Ph.D. 2005 from Osaka University, Japan. Honorary Fellow at Asahi Kasei Corporation, Tokyo, Japan and Professor at Meijo University, Nagoya, Japan.

"for the development of lithium-ion batteries"

REFERENCE:

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NOBEL PRIZE WINNER IN CHEMISTRY 1911

DISCOVERY OF RADIOACTIVE ELEMENTS

PRIYA R.

II B.Sc.

INTRODUCTION:

The Discovery of Radioactivity was a gradual process that started in 1895 with Wilhelm Conrad Roentgen's discovery of X-rays and was later advanced by scientists like Henri Becquerel and the Curie family.

HENRI BECQUEREL DISCOVERY:

In 1896, while studying the phosphorescence of uranium salts, Henri Becquerel noticed that they emitted rays that the Periodic table there are 38 radioactive elements.

Examples like Uranium, Radium, Polonium, Bismuth were able to pass through paper and darken photographic plates. From this, he understood that uranium showed radioactive behaviour. He believed the rays were a type of Phosphorescence. But further investigation revealed they were a new phenomenon. He is the father of Radioactive elements.

MARIE CURIE DISCOVERY:

In 1911, Marie Curie was awarded the Nobel Prize in chemistry for her discovering of the elements radium and polonium. Afterwards she found that thorium emitted the same type of rays as Uranium. Through her detailed studies of various chemical compounds, she made a surprising discovery – the intensity of radiation did not depend on the type of compounds but solely on the amount of Uranium, Thorium.

Compounds made from the same elements often show very different chemical and physical characteristics. Example: One Uranium compound may appear as a dark powder while another is a clear yellow crystal – the radiation they produce was determined by the quality of Uranium they contained. This led Marie Curie to conclude that radioactivity was not related to the arrangement of atoms in a molecule but to the atom's internal structure itself.

The Nobel Committee honoured her "for advancing chemistry through the discovery of radium and polonium, and for successfully isolating radium."

PIERRE CURIE JOINEDWITH MARIE CURRIE:

Pierre Curie set aside research on crystal and natural symmetry to join Marie in her investigation. Together, they discovered that the most intense was found in portions containing either bismuth or barium.

As Marie kept examining the bismuth fractions, each time she removed some bismuth, leftover substance showed even stronger activity.

They noted “We think the substance extracted from pitchblende contains a new metal, unknown until now, with analytical properties similar to bismuth”. If confirmed, we propose naming it Polonium. That was the first occasion when the term radioactivity was Introduced.

A few months later, on December 26 1898, the Curie announced to the I Academie des Science that they had strong evidence of another highly active substance, chemically similar to pure barium. They proposed the name radium for this new element.

UNITS OF RADIOACTIVITY:

The rate at which a radioactive sample gives off radiation is measured in Becquerel (Bq), named after Henry Bequerel.

Earlier, a unit called the Curie was used, named after Pierre and Marie Curie. One curie represents the activity of roughly 1 gram of radium.

29 RADIOACTIVE ELEMENTS IDENTIFIED BY SCIENTISTS

- Technetium (Tc) - Transition metal
- Promethium (Pm) - Rare earth metal
- Polonium (Po) - Metalliod
- Radon (Rn) - Noble gas
- Astatine (At) - Halogen
- Francium (Fr) - Alkali Metal
- Radium (Ra) - Alkali Earth Metal
- Actinium (Ac) - Rare Earth metal
- Thorium (Th) - Rare Earth Metal
- Protactinium (Pa) - Rare Earth Metal
- Uranium (U) - Rare Earth Metal
- Neptunium (Np) - Rare Earth Metal
- Plutonium (Pu) - Rare Earth Metal
- Americium (Am) - Rare Earth Metal
- Curium (Cm) - Rare Earth Metal
- Berkelium (Bk) - Rare Earth Metal
- Californium (Cf) - Rare Earth Metal
- Einsteinium (Es) - Rare Earth Metal
- Fermium (Fm) - Rare Earth Metal
- Mendelevium (Md) - Rare Earth Metal

- Nobelium (No) - Rare Earth Metal
- Lawrencium (Lr) - Rare Earth
- Rutherfordium (Rt) or Kurchatovium (Ku) - Transition Metal
- Dubnium (Db) or Nilsborium (Ns) - Transition Metal
- Seaborgium (Sg) - Transition Metal
- Bohrium (Bh) - Transition Metal
- Hassium (Hs) - Transition Metal
- Meitnerium (Mt) - Transition Metal

USES OF RADIOACTIVE ELEMENTS IN REAL LIFE

1. Cobalt – Treats cancer
2. Iodine – checks thyroid
3. Uranium^{235} – fuel nuclear reactor
4. Americium^{241} – smoke detector
5. Carbon^{14} – Dating old artefacts
6. Gallium^{68} – Used in PET Scans

"ONE NEVER NOTICES WHAT HAS BEEN DONE; ONE CAN ONLY SEE WHAT REMAINS TO BE DONE"

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NOBEL PRIZE IN CHEMISTRY BY SCIENTIST OF INDIAN ORIGIN

E. HEMALATHA

II M.Sc

INTRODUCTION

Venkatraman Ramakrishnan, born on April 5, 1952, in Chidambaram, Tamil Nadu, India, is a distinguished structural biologist whose groundbreaking research has significantly advanced our understanding of the molecular structure and function of ribosomes. His contributions to science, particularly in elucidating the atomic structure of the ribosome, have earned him international acclaim, including the Nobel Prize in Chemistry in 2009. Ramakrishnan's career spans decades of scientific inquiry, leadership in research institutions, and advocacy for scientific education and policy.

Transition to Biology and Structural Biology

Venkatraman Ramakrishnan transitioned to biology, realizing his interest in molecular biology and biochemistry. He joined the University of California, San Diego (UCSD), where he conducted postdoctoral research in David Eisenberg's laboratory, studying the structure and function of ribonucleases. This experience ignited Ramakrishnan's passion for structural biology, a field that combines techniques from physics, chemistry, and biology to study the three-dimensional structures of biological molecules.

Ribosome Structure and Nobel Prize

Venkatraman Ramakrishnan's most significant scientific achievement came from his work on the structure of the ribosome, a complex molecular machine essential for protein synthesis in cells. In collaboration with colleagues, including Thomas A. Steitz and Ada Yonath, Ramakrishnan used X-ray crystallography to determine the atomic structure of the ribosome. Their research provided unprecedented insights into how the ribosome functions at the molecular level, revealing its intricate architecture and mechanisms of protein synthesis. For their pioneering work, Venkatraman Ramakrishnan, Thomas A. Steitz, and Ada Yonath were jointly awarded the Nobel Prize in Chemistry in 2009. Ramakrishnan's contributions not only advanced our fundamental understanding of biological processes but also laid the foundation for developing new antibiotics and therapeutic strategies targeting ribosomes.

Awards and Honors

Venkatraman Ramakrishnan's contributions to science have been recognized with numerous

awards and honors, in addition to the Nobel Prize in Chemistry. He is a Fellow of the Royal Society (FRS), a member of the US National Academy of Sciences, and a Foreign Member of several other prestigious academies worldwide. Ramakrishnan's accolades underscore his influence and impact on the global scientific community, as well as his dedication to advancing knowledge and fostering international collaboration in science.

Conclusion

In conclusion, Venkatraman Ramakrishnan's career exemplifies the transformative impact of structural biology on our understanding of molecular mechanisms in living organisms. His Nobel Prize-winning research on the ribosome has revolutionized the field of molecular biology, paving the way for new discoveries and applications in medicine, biotechnology, and drug development. Ramakrishnan's leadership in scientific institutions, advocacy for science communication, and commitment to ethical conduct have made him a role model for scientists worldwide.

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BIOLOGY MEETS CODE:

HOW DAVID BAKER TURNED A COMPUTER INTO A PROTEIN FACTORY

ARUL MOZHI S S

II M.Sc.

INTRODUCTION:

In 2024, Dr. David Baker, a professor of biochemistry at the University of Washington and director of the Institute for Protein Design, was awarded the Nobel Prize in Chemistry. His recognition came for something once thought impossible: designing entirely new proteins—molecules essential to all forms of life—using computer algorithms. While many researchers have focused on understanding and predicting existing protein structures, Baker went further. He developed tools like Rosetta and RoseTTAFold that enabled scientists to build proteins from scratch, with custom-made structures and purposes. This opened new frontiers in medicine, materials science, and green chemistry, marking a monumental step in computational biology.

Why Traditional Protein Design Was Limited

Proteins are the workhorses of the cell, responsible for everything from digestion to DNA repair. These completely depend on their 3D structures, determined by the specific sequence of amino acids. Traditionally, scientists studied natural proteins using experimental techniques like X-ray crystallography or NMR spectroscopy. But these processes were slow, expensive, and unpredictable. Designing new proteins manually was even harder, like trying to build a machine without understanding how its parts fit together. Researchers could alter existing proteins a little—but they couldn't engineer new ones with tailor-made functions, and they had no reliable way to predict how a given amino acid sequence would fold. Biology needed a better blueprint.

A New Era for Students and Scientists

For students, the rise of computational protein design means science is becoming more interactive, inclusive, and hands-on. With free access to Rosetta software and platforms like Foldit, learners no longer need an expensive lab to explore biology—they only need curiosity and a computer. Professors are using these tools to teach advanced concepts like protein folding, thermodynamics, and molecular modelling in ways that are both engaging and practical. And for young scientists, this field offers a path to cutting-edge careers in biotechnology, pharmaceuticals, artificial intelligence, and more. As Baker's vision spreads, it empowers a global generation to design solutions to tomorrow's challenges.

Real-World Applications: Protein Design

Antivirals and Vaccine Development

During the COVID-19 pandemic, Baker's lab responded by designing miniproteins that could tightly bind to the coronavirus's spike protein—neutralizing the virus in early studies. These antivirals were created in less than two months, showcasing the speed and flexibility of computational design

Protein-Based Therapeutics

Computationally designed proteins are now being explored to target cancer cells, deliver drugs, and even correct genetic defects. For diseases like Alzheimer's, researchers are working on proteins that bind to and neutralize toxic aggregates in the brain.

Smart Biomaterials

Engineered proteins are also being used to create nanostructures, biosensors, and self-assembling materials. These could lead to the next generation of responsive implants, targeted therapies, and even tissue regeneration tools.

CONCLUSION:

David Baker’s Nobel Prize marks more than just a personal achievement—it signals the arrival of digital biology, where molecules are designed like blueprints and made real through computation. His vision has reshaped the way scientists think about life, turning protein creation from a mystery into a design problem. For chemists, this opens a new toolkit to build susceptible molecules. For professors, it means teaching biology through interactive, computer-aided platforms. For students, it’s an invitation to explore life’s code and write their own solutions to the world's most urgent problems. Biology has met code—and together, they are shaping the future.

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JACOBUS HENRICUS VAN 'T HOFF

RENU PRIYA.K

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INTRODUCTION

J H van't Hoff is regarded as one of the greatest chemists of all time. He began his career as an organic chemist and solved the complex issue of optical isomerism by introducing the concept of tetrahedral carbon atoms forming different groups at the apexes of a tetrahedron. He extended this idea to include geometric isomerism and compounds with heteroatoms instead of asymmetric carbon atoms, thus laying the foundation of stereochemistry. He later delved into reaction kinetics, chemical equilibria, thermodynamic properties of dilute solutions, and related fields. These contributions are regarded as the foundation of physical chemistry and earned him the first Nobel Prize in Chemistry in 1901. van 't Hoff passed away from tuberculosis at the age of 59.

NEW BRANCH OF CHEMISTRY

By the early 1880s, van 't Hoff shifted his focus from molecular structures to molecular transformation. His areas of interest included reaction kinetics, chemical equilibria, dilute solutions, chemical affinity, and thermodynamics. In 1884, he published a book titled *Studies in Chemical Dynamics* that explained how temperature affects reaction equilibria. In 1885, Henri Le Chatelier expanded on this idea, and it is now known as the van 't Hoff–Le Chatelier principle.

He also developed a graphical method for determining rate constants and reaction orders and proposed the van 't Hoff equation, which describes the relationship between the equilibrium constant and the heat of reaction. His ideas on temperature's effect on equilibrium were further developed by Svante Arrhenius in 1889, leading to the Arrhenius equation. van 't Hoff also collaborated with Wilhelm Ostwald in the field of kinetics. Around the same time, he became aware of Wilhelm Pfeffer's findings on osmotic pressure and its dependence on the concentration and temperature of a solution. These studies, which Pfeffer had conducted earlier in 1877, were quickly grasped by van 't Hoff, who drew similarities with the gas laws. This led him to derive an equation for osmotic pressure and demonstrate that the thermodynamic laws applicable to gases are equally valid for dilute solutions. When this was later extended to ionic substances by Arrhenius, it was necessary to propose the dissociation of electrolytes to ensure the osmotic pressure law held true. This ultimately led to the development of the electrolytic dissociation theory by Arrhenius (1884–87). These discoveries had significant implications in the natural sciences, as they laid the groundwork for many biological functions and phenomena such as freezing point depression, electrolyte dissociation, reverse osmosis, and more.

STRUGGLES BEHIND A SCIENTIST

van 't Hoff achieved these groundbreaking discoveries while balancing a heavy load as a professor. He often lamented the limited time he had for research, citing it as one of the reasons he moved from Amsterdam to Berlin. However, it should be noted that he was primarily a theoretical chemist, not an experimental one. His genius lay in his ability to identify central principles from vast amounts of experimental data collected by others. This is clearly evident in his explanation of optical activity, which was based on the optical rotation data from published literature.

ACHIEVEMENT OF NOBEL PRIZE

van 't Hoff's Nobel Prize-winning work on osmotic pressure relied heavily on the experimental findings of W Pfeffer, H de Vries, and Eilhard Mitscherlich. In an obituary, Wilder Dwight Bancroft mentioned that van 't Hoff admitted to the importance of these experimental results. Bancroft noted that van 't Hoff never conducted precise measurements himself and did not care to. He once said, "How fortunate it is that there are people who do that sort of work for us!"

However, one cannot blame van 't Hoff for this, as the experimenter may not realize the theory hidden in their data. Neither Pfeffer, who conducted many osmotic pressure measurements, nor Rudolf Clausius, with whom Pfeffer discussed the problem, recognized the relationship between concentration and temperature. Van 't Hoff, on the other hand, immediately grasped the similarity with the gas laws upon learning about Pfeffer's findings from de Vries. Through his own work and that of his contemporaries like Wilhelm Ostwald and Svante Arrhenius, he realized that physical chemistry would emerge as a separate branch of chemistry. In 1887, he co-edited the *Zeitschrift für Physikalische Chemie* until his death.

With such extraordinary, pioneering contributions to physical chemistry, it is no wonder that he is called the Father of Physical Chemistry and is considered one of the greatest chemists of all time, along with Antoine Lavoisier, Louis Pasteur, and Friedrich Wöhler. He was selected to receive the inaugural Nobel Prize in Chemistry in 1901.

MAJOR CONTRIBUTIONS

- 1874 : Provided an explanation for optical activity in organic compounds by proposing the asymmetry of carbon atoms forming different groups arranged at the apexes of a tetrahedron – the beginning of stereochemistry.

- 1884 : Published *Studies in Chemical Dynamics*, describing a new graphical method (differential method) for determining reaction order.

Derived equations for reaction rates and chemical equilibria. Applied thermodynamic principles and introduced the concept of chemical affinity (van 't Hoff equation).

- 1885 : Developed the theory of osmotic pressure, demonstrating its relation to concentration and temperature, and showing the applicability of gas laws to dilute solutions

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FRANCES H. ARNOLD AND THE INVENTION OF DIRECTED EVOLUTION: A TRANSFORMATIVE BREAKTHROUGH IN CHEMISTRY

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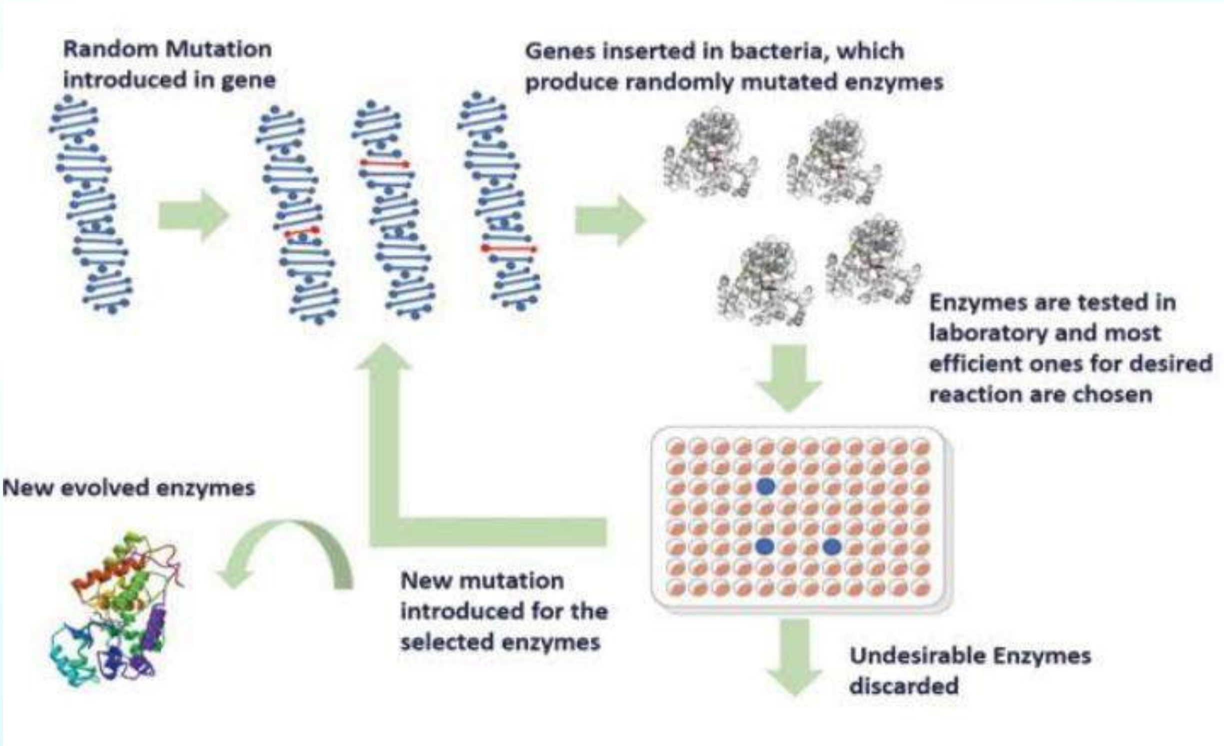
Introduction

Frances H. Arnold, a pioneer in chemical engineering, reshaped the landscape of biotechnology and green chemistry through her groundbreaking invention of Directed Evolution. Her approach imitates the natural selection process in the laboratory, allowing scientists to evolve proteins and enzymes with desirable properties without fully understanding their complex structures. This method has not only advanced fundamental research but has also had a profound impact on industrial applications, including drug manufacturing, biofuel production, and green chemical processes.



The Concept of Directed Evolution

Directed Evolution operates by introducing random mutations into the DNA that encodes a protein. These mutations create a diverse library of genetic variants. Scientists then express these DNA variants in microorganisms such as bacteria or yeast, producing thousands of protein variants. Through high-throughput screening or selection processes, the most effective or efficient proteins are identified and used as templates for further rounds of mutation. This iterative cycle of mutation and selection mirrors natural evolution but accelerates it dramatically in a controlled laboratory environment.

Historical Development of the Method

Frances Arnold conceived the idea of Directed Evolution in the late 1980s while working at Caltech. Frustrated by the limitations of protein design through rational methods, Arnold realized the potential of leveraging evolution itself to achieve useful biological functions. She believed in 'letting nature do the work,' by selecting proteins with superior traits without needing to comprehend every detail of protein folding and function. Her first successful demonstration came in 1993, where she applied directed evolution to engineer the enzyme subtilisin with improved performance in organic solvents.

Real-world Applications and Impact

Arnold’s Directed Evolution has revolutionized various industries:
• Biofuel Production: Her engineered enzymes efficiently break down cellulose, converting plant biomass into sugars for renewable fuel production.

• Pharmaceuticals: Companies like Merck utilized her methods to develop greener, more efficient processes for manufacturing drugs, such as the diabetes medication Januvia.

• Green Chemistry: Directed Evolution reduces the need for toxic chemicals and harsh reaction conditions, promoting environmentally friendly industrial practices.

• New-to-Nature Chemistry: Arnold's more recent research enabled the creation of enzymes that catalyze novel chemical reactions, such as forming silicon-carbon and boron-carbon bonds, expanding the capabilities of synthetic biology.

Industrial and Academic Influence

Her invention has influenced hundreds of research laboratories and industrial operations worldwide. Directed Evolution is now a foundational technique in protein engineering and has opened doors to applications in agriculture, materials science, and renewable energy. Arnold co-founded Gevo, a biofuels company, highlighting her commitment to translating scientific innovation into practical, sustainable technologies.

Personal Motivation and Recognition

Arnold’s personal mission has always been intertwined with sustainability and practical problem-solving. Her success is reflected in her extensive collection of awards and honors, including the Nobel Prize in Chemistry (2018), the National Medal of Technology and Innovation, and membership in the National Academies of Sciences, Medicine, and Engineering. She overcame skepticism from peers who dismissed random mutagenesis approaches, proving the immense power of her vision through impactful, real-world outcomes.

Conclusion

Frances H. Arnold’s invention of Directed Evolution stands as a monumental achievement in modern chemistry. By harnessing nature’s own evolutionary mechanisms, she provided a toolkit for scientists to solve some of humanity’s pressing challenges—creating sustainable technologies, advancing medicine, and revolutionizing industrial processes. Her legacy continues to inspire researchers and industry leaders toward greener and more innovative solutions.

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CLIMATE CHANGE

ROLE OF CHEMISTRY IN CLIMATE CHANGE

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INTRODUCTION:

Climate change is one of the most pressing global challenges of the 21st century. Driven primarily by the accumulation of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), it leads to global warming, rising sea levels, extreme weather events, and disruptions in ecosystems. Chemistry plays a central role in understanding, mitigating, and adapting to climate change through the analysis of atmospheric processes, development of clean energy technologies, and innovations in carbon capture and utilization.

ROLE OF CHEMISTRY:

1. Greenhouse Gases and Atmospheric Chemistry:

Chemistry helps in understanding how greenhouse gases interact with radiation and contribute to the greenhouse effect. Spectroscopic techniques are used to monitor and quantify GHG concentrations in the atmosphere.

- ✓ CO_2 is released by fossil fuel combustion, respiration, and deforestation.
- ✓ CH_4 is emitted from agriculture (especially livestock), landfills, and natural gas leaks.
- ✓ N_2O originates from fertilizer use and certain industrial processes.

Reactions involving hydroxyl radicals (·OH) in the atmosphere control the lifetimes of CH_4 and other pollutants, a critical area of research in environmental chemistry.

2. Chemistry of Carbon Capture and Storage (CCS):

One major strategy to combat climate change is to capture CO_2 from power plants and industrial sources and store it underground (geological sequestration).

- ✓ **Chemical Absorption:** CO_2 is captured using amines (like monoethanolamine, MEA), forming carbamates.

  Example:

  $$CO_2 + 2RNH_2 \rightarrow RNHCOO^- + RNH_3^+$$

- ✓ **Mineral Carbonation:** Converts CO_2 into stable carbonates using minerals like olivine or serpentine.

These chemical methods are being optimized for energy efficiency and scalability.

3. Green Chemistry and Sustainable Processes:

Green chemistry focuses on designing products and processes that minimize the use and generation of hazardous substances.

Key principles relevant to climate change:

- ✓ Use of renewable feedstocks (e.g., biomass instead of petroleum)
- ✓ Energy-efficient reactions (e.g., catalysis at ambient temperature)
- ✓ Designing for degradation to reduce plastic pollution

Sustainable catalysis and solvent-free reactions reduce the carbon footprint of the chemical industry.

4. Alternative Energy Sources and Fuels:

Chemists contribute to the development of clean energy technologies such as:

Hydrogen fuel: Electrolysis of water using renewable electricity (solar/wind) to generate hydrogen as a clean fuel.

$$2H_2O \rightarrow 2H_2 + O_2$$

Photovoltaics: Chemistry of semiconductors (like silicon, perovskites) is crucial in developing efficient solar cells.

Biofuels: Produced from biological materials like algae or agricultural waste; involve chemical conversion of cellulose into ethanol or biodiesel.

5. Climate-Responsive Materials

Chemists are developing new materials that respond to climate challenges:

Thermal insulators and phase change materials (PCMs) to reduce energy demand for heating and cooling.

Reflective coatings for buildings to reduce heat absorption.

Smart polymers that change properties with temperature, useful in wearable climate sensors.

6. Analytical Chemistry and Climate Monitoring:

Advanced analytical techniques are used for:

Monitoring GHG levels: Infrared spectroscopy, gas chromatography.

- ✓ **Gas Chromatography (GC):** Identifies and quantifies trace atmospheric gases.
- ✓ **Infrared Spectroscopy (FTIR):** Measures CO_2, CH_4, and N_2O via their characteristic IR absorption bands.
- ✓ **Isotopic analysis:** Determines sources of CO_2 (biogenic vs. anthropogenic) using $\delta^{13}C$ and $\delta^{18}O$ signatures.

Studying ice cores: Reveal historical CO_2 levels and temperature data.

Air quality analysis: Detect pollutants like ozone, NOx, and volatile organic compounds (VOCs).

CONCLUSION:

Chemistry is not only vital in understanding the causes of climate change but also in offering practical solutions. From capturing CO_2 and designing sustainable materials to developing clean fuels and monitoring atmospheric changes, chemistry is at the forefront of the global response to climate change. Encouraging innovation in green chemistry and fostering interdisciplinary collaboration will be essential to creating a more sustainable future.

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STUDY ON CLIMATE CHANGE: ITS IMPACTS AND RESPONSES

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Introduction:

Climate change represents a systemic challenge that transcends environmental boundaries and directly influences social, economic, and political structures. Anthropogenic greenhouse gas emissions, deforestation, and industrialization have accelerated global warming, destabilizing climate systems at both macro and micro scales. This article provides a detailed analysis of the impacts and effects of climate change, evaluates key mitigation and adaptation measures, and discusses the long-term consequences of inaction. It is essential to emphasis on the necessity of immediate, multidisciplinary responses to maintain ecological equilibrium and socio-economic resilience. Climate change is no longer a hypothetical future threat but an observable reality with measurable consequences. This change, primarily driven by human activities such as burning fossil fuels, deforestation, and intensive agriculture, challenges planetary boundaries and poses complex risks to human and natural systems.

Characteristics of climate change:

Climate change is a long-term alteration in Earth's average weather pattern and temperature, primarily driven by natural processes and significantly accelerated by human activities such as fossil fuel combustion, deforestation, and industrial emissions of greenhouse gases. It results in measurable changes in temperature, precipitation, wind patterns, and the frequency and intensity of extreme weather events.

Characteristics:

1. **Global Temperature Rise:** Continuous increase in average surface temperatures.
2. **Changing Precipitation Patterns:** Irregular rainfall, prolonged droughts, and intense floods.
3. **Melting of Ice and Snow:** Retreat of glaciers, polar ice cap reduction, and permafrost thawing.
4. **Rising Sea Levels:** Due to thermal expansion and melting ice sheets.
5. **Extreme Weather Events:** Increased frequency and severity of cyclones, heatwaves, and wildfires.
6. **Ecosystem Disruption:** Loss of biodiversity, habitat shifts, and ocean acidification.
7. **Anthropogenic Influence:** Strong link to human activities, especially greenhouse gas emissions.

Impacts and Effects:

Climate change has led to rising global temperatures, unpredictable rainfall patterns, and the melting of glaciers and polar ice, causing sea-level rise and more frequent extreme weather events such as floods, droughts, and heatwaves. These changes disrupt ecosystems, leading to biodiversity loss, ocean acidification, and shifts in agricultural productivity. Human societies face significant challenges including food insecurity, freshwater scarcity, increased health risks from heat-related illnesses and vector-borne diseases, and large-scale displacement of populations from climate-vulnerable regions. The economic impact is profound, with damage to infrastructure, reduced labor productivity, and greater expenditure on disaster management and healthcare.

Control and Mitigation:

Mitigation of climate change involves reducing greenhouse gas emissions through renewable energy adoption, improved energy efficiency, sustainable agricultural practices, and afforestation. Technological solutions like carbon capture and storage (CCS), electric mobility, and circular economy models further support emission reduction. Adaptation strategies include developing climate-resilient infrastructure, efficient water resource management, and ecosystem-based approaches such as wetland and mangrove restoration. Policies like carbon pricing, green finance, and international agreements (e.g., the Paris Agreement) play a crucial role, alongside public awareness and lifestyle changes, in addressing the climate crisis and ensuring long-term sustainability.

Consequences of Inaction

Environmental Consequences

- **Irreversible Ecosystem Damage:** Loss of coral reefs, tropical rainforests, and biodiversity hotspots.
- **Sea-Level Rise:** Permanent inundation of coastal cities (e.g., Jakarta, Miami) and small island nations.

Socio-Economic Consequences

- **Food and Water Wars:** Resource scarcity leading to armed conflicts.
- **Mass Migration:** Increased climate refugees straining international relations.
- **Global Economic Decline:** Severe disruptions in supply chains, healthcare costs, and employment losses.

Feedback Loops

- **Permafrost Melting:** Releases trapped methane, amplifying global warming.
- **Albedo Effect Loss:** Melting ice reduces Earth's reflectivity, increasing heat absorption.

Conclusion:

Climate change is not only an environmental issue but a multidimensional crisis affecting health, economy, politics, and culture. Effective control requires immediate implementation of mitigation strategies (emission reduction, renewable energy transition) and adaptation measures (resilient infrastructure, ecosystem restoration). The consequences of inaction are severe and potentially irreversible, making climate change a defining issue for current and future generations.

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ATMOSPHERIC ALCHEMY: HOW CHEMICAL REACTIONS SHAPE OUR CLIMATE

DILLIRANI M.

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Introduction:

We usually think of chemistry as something that happens in laboratories, with bubbling beakers and colorful reactions. But some of the most important chemical reactions happen above us, *in the sky*. Every second, our atmosphere hosts countless chemical interactions that influence the Earth's temperature, air quality, and weather patterns. This invisible chemistry, driven by sunlight, gases, and particles, plays a major role in climate change. From ozone breakdown to CO_2 buildup, and even the creation of acid rain, the chemistry of the atmosphere is both complex and crucial to understanding our warming planet. In many ways, it's like a form of modern alchemy, a science of transformation that's changing the climate itself.

Atmospheric Alchemy

1. **The Sky's Lab**: Natural Atmospheric Chemistry

The atmosphere is a giant chemical laboratory. The atmosphere of Earth is made up largely of nitrogen, which accounts for roughly 78%, and oxygen, which makes up about 21%. In addition, it contains only trace quantities of gases like carbon dioxide, ozone, methane, and water vapor. Natural processes like photosynthesis, volcanic eruptions, lightning, and solar radiation drive chemical reactions such as:

- Oxygen turning into ozone at the stratosphere

$$O_2 + \text{UV light} \rightarrow 2O \rightarrow O_3$$

- Water vapor forms clouds through condensation.
- Nitrogen oxides reacting during thunderstorms.

These reactions help regulate Earth's temperature and protect us from harmful solar rays. The ozone layer serves as a protective cover around our planet, blocking most of the sun's harmful ultraviolet rays and helping to maintain conditions suitable for life on Earth.

2. **Human-Caused Chemical Chaos:**

Unfortunately, many human activities are altering atmospheric chemistry in harmful ways. Large volumes of reactive gases are released into the air through activities such as fuel combustion, factory operations, and modern farming techniques. Some of the man made chemical adverse scenarios are:

- CO_2 and CH_4 trap heat (greenhouse effect)
- NO_x and SO_2 form acid rain when combined with water
- Chlorofluorocarbons (CFCs) destroy ozone in the stratosphere
- A key example is the formation of ground-level ozone (bad ozone), caused when sunlight reacts with nitrogen oxides and volatile organic compounds (VOCs):

$$NO_2 + \text{sunlight} \rightarrow NO + O \rightarrow O + O_2 \rightarrow O_3$$

This ozone, unlike the protective layer in the upper atmosphere, is harmful to both humans and plants, contributing to smog and respiratory issues.

3. **Climate-Altering Reactions and Their Impact:**

Atmospheric chemistry forms the core of climate change. Some reactions, though invisible, have massive effects:

- When methane breaks down, it produces water vapor and carbon dioxide, both of which are powerful greenhouse gases.

  $$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

- Aerosol particles, produced by burning fossil fuels, reflect sunlight and cool the Earth temporarily but they also affect cloud formation and rainfall.
- Nitrous oxide (N_2O) from fertilizers breaks down slowly and absorbs heat in the atmosphere for over 100 years.

These chemical processes are shifting climate systems, altering monsoons, melting polar ice, and leading to extreme weather events. Scientists are now studying these reactions using satellites, spectrometers, and climate models to better understand and hopefully reverse the damage.

Conclusion:

Atmospheric chemistry may be invisible to the eye, but it's one of the most powerful forces shaping our climate. Each time smoke rises, fuel burns, or carbon dioxide is released, it sets off chemical processes in the atmosphere that affect the entire planet. Understanding these processes is the first step toward creating a cleaner, cooler planet. If we want to change the future, we must respect and rebalance the alchemy of the atmosphere before it's too late.

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ELECTROCHEMICAL CO_2 CONVERSION: A SUSTAINABLE APPROACH TO CLIMATE CHANGE MITIGATION

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INTRODUCTION

Climate change is one of the most serious concerns of the 21st century, primarily caused by anthropogenic CO_2 emissions. Traditional mitigation strategies, such as carbon capture and storage (CCS), have limited sustainability. Electrochemical CO_2 conversion (ECO_2R) is a revolutionary green technology that uses renewable electricity to convert CO_2 into valuable chemicals like methane, ethylene, methanol, and carbon monoxide.

PRINCIPLES OF ELECTROCHEMICAL CO_2 REDUCTION

ECO_2R simulates the process of natural photosynthesis. Using electrons from an external power source, CO_2 is dissolved in an aqueous electrolyte and reduced at the cathode. Water oxidation is aided by the anode.

General reaction:

$CO_2 + H_2O + \text{electrons} \rightarrow \text{Hydrocarbon} + O_2$

Example (methane production):

$CO_2 + 8H^+ + 8e^- \rightarrow CH_4 + 2H_2O$

Key requirements:

- High surface area electrodes
- Efficient electrocatalysts
- Stable electrolyte medium

CATALYSTS AND MECHANISMS

The catalyst's nature has a significant impact on the reaction mechanism.
Copper (Cu): Unique among metals for its ability to reduce CO_2 to hydrocarbons like ethylene (C_2H_4) and ethanol (C_2H_5OH).

Silver (Ag), Gold (Au): Selectively reduce CO_2 to carbon monoxide (CO).

Nickel (Ni), Iron (Fe): Preferred in low-cost and earth-abundant catalyst development
Mechanistic pathway for methanol production:

$\mathbf{CO_2 + 6H^+ + 6e^- \rightarrow CH_3OH + H_2O}$

Proton-coupled electron transfer (PCET) governs these conversions, where both proton and electron are simultaneously transferred.

PHOTOELECTROCHEMICAL CELLS (PEC) Coupling ECO_2R with solar energy boosts sustainability.

Cathode: Catalyst-coated electrode for CO_2 reduction

Anode: Typically IrO_2 or RuO_2 for water oxidation

Photocathode: Semiconductors like TiO_2, GaP, or perovskites

PEC cells act as artificial leaves, harvesting sunlight to drive CO_2-to-fuel conversion.

FUTURE SCOPE AND APPLICATIONS

1. **Fuel production:** clean energy using ethanol, methanol, and methane
2. **Carbon-neutral sectors:** Chemical industry substitution of fossil feedstocks
3. **Integration of the grid:** Utilising sporadic renewable energy
4. **Decentralised CO2 recycling:** Transportable industrial flue gas recycling systems

Challenges:

- Catalyst stability
- Low selectivity and efficiency
- Scale-up and commercial viability
- Ongoing research focuses on nanostructured catalysts, tandem PEC devices, and hybrid systems to improve product yields and energy efficiency.

CONCLUSION

By converting waste CO_2 into fuels and chemicals using green electricity, electrochemical CO_2 conversion is a revolutionary step towards carbon neutrality. This technology is crucial for combating climate change and facilitating future energy independence since it serves as a link between chemistry and sustainability.

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CLIMATIC CHANGE AND ITS IMPACT – NUCLEAR WINTER

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CLIMATIC CHANGE:

The chemistry behind climate change involves the release of greenhouse gases such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (NO2). It absorbs the heat in the atmosphere, which leads to global warming.

IPCC report:

The Intergovernmental Panel on Climate Change (IPCC) released a new report, which brings the most recent advances in climate science together. The report, which was approved by 195 national governments, shows the rapid human-induced change occurring in our climate.

CLIMATIC CHANGE BASED ON CHEMICALS USED IN WORLD WAR:

The relationship between climatic change and chemicals used in world war bombs is significant.

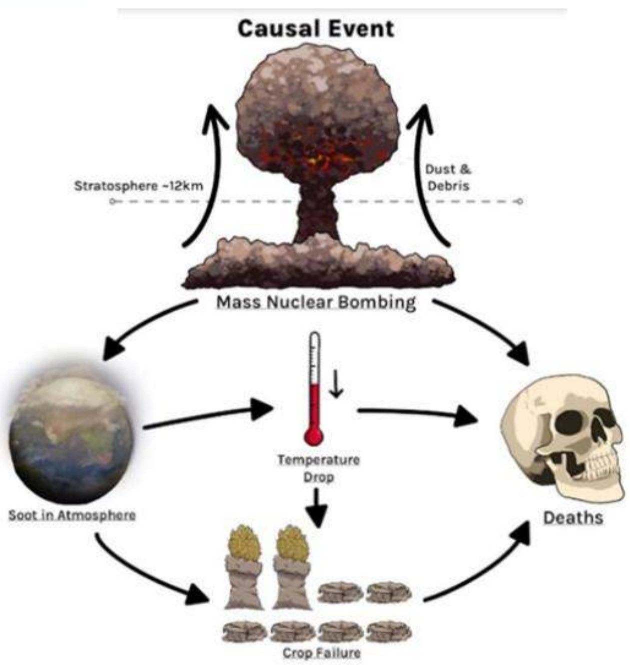
- Nuclear winter
- Intersection of chemical warfare and climate change
- Explosive materials
- Smoke from fires

These factors illustrate the profound impact of chemical warfare on both environmental and climatic systems.

NUCLEAR WINTER:

Nuclear winter is a prolonged global climatic cooling effect that could occur after widespread urban firestorms following a large-scale nuclear war.


Nuclear winter refers to the climatic changes that result from the smoke and soot produced by nuclear explosion. When nuclear weapons detonate, the ignite massive fires in urban areas, forests and other flammable materials. These fires releases large amount of particulate matter into the atmosphere, specifically into the stratosphere where it block the sunlight from reaching the Earth's surface. This leads to cooling of the planet which last for years or even decades.



Graphic used in the poll to explain nuclear winter

POTENTIAL CONSEQUENCES:

1. Global Cooling
2. Widespread Famine
3. Mass Extinction
4. Radiation and Infrastructure Damage

CONCLUSION:

Nuclear winter represents one of the most severe potential consequences of nuclear warfare, with implications that extend far beyond immediate destruction. It could lead to drastic global cooling, crop failure and massive starvation.

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ARTIFICAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE IN LABORATORY

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INTRODUCTION

Step inside a laboratory of the past and you would find glass beakers, microscopes, and researchers bent over experiments for hours. Step into the laboratory of today, and you might see something surprising: a robot arm preparing test samples, an AI program predicting the outcome of experiments, and a digital assistant sending results straight to a scientist's laptop. This is not science fiction. This is the age of Artificial Intelligence (AI) in laboratories—and it's changing the way science is done forever.

WHEN ROBOTS BECOME SCIENTISTS

In modern research labs, robots are no longer just machines; they are co-scientists.

At Dash Bio, robots powered by AI now run common lab tests in record time, ensuring accuracy and freeing human researchers to focus on discoveries.

At Carnegie Mellon University, an AI system called Coscientist has been trained to design, plan, and carry out experiments remotely. Imagine designing your project in a classroom while your AI partner executes it in a high-tech lab miles away.

Did You Know:

"Some labs are already called "cloud labs", where experiments can be run online from anywhere in the world**".**

AI IN LABORATORIES

AI's biggest breakthrough in laboratories has been in medicine and diagnostics.

In hospitals, AI is scanning pathology slides and spotting diseases faster than the human eye.

At Singapore General Hospital, AI helps pathologists find cancerous cells more quickly, cutting down waiting times for patients.

"AI isn't replacing doctors—it's giving them a powerful partner."

This partnership means fewer errors, quicker diagnoses, and lives saved.

SMARTER EXPERIMENTS SAVES TIME

Every researcher knows how frustrating failed experiments can be. AI is helping here too:

It predicts when lab equipment will fail before it actually does.It manages chemical supplies and orders new ones automatically.It can even run simulations of experiments to test ideas before a single drop of liquid is used.

Lab Hack with AI

AI-driven labs can cut costs by reducing wasted materials and minimizing failed trials—great news for universities and startups

The Lab of the Future

What might laboratories look like in 2035? The future is closer than you think:

Robot Dogs in Labs – Researchers have tested robotic quadrupeds with AI that can patrol labs, check equipment, and generate reports.

Lab-on-a-Chip – AI-powered microfluidic chips can run dozens of biology experiments on a device smaller than your phone.

24/7 Science – Labs will run continuously, with machines carrying out experiments day and night while scientists guide them from afar.

Shaping the Scientists of Tomorrow

The rise of AI in laboratories is not just about machines—it's about the next generation of scientists.

Future researchers will:

Spend less time on routine tasks and more time on creative problem-solving.Use AI to collaborate globally, running experiments in labs thousands of kilometers away.Lead discoveries in medicine, energy, and space by combining human imagination with machine intelligence.

The scientist of tomorrow will not just be a chemist, biologist, or physicist—they will be a navigator of intelligence, steering both human curiosity and artificial insight toward new horizons.

CONCLUSION

AI in laboratories is not simply a tool. It is becoming a partner in discovery, a silent force accelerating science, and a bridge to breakthroughs we once thought impossible.

The next great medical cure, the next revolutionary energy source, or the next discovery about life itself may not come from a single scientist—but from a human–AI partnership inside the laboratories of the future.

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QUALITY ASSESSMENT OF FOOD - "HOW EASIER IS THE DETECTION THROUGH ARTIFICIAL INTELLIGENCE"

REGINA DARLONG

I M. Sc.

Introduction:

Food plays a vital role in giving us the all the necessary proteins vitamins and minerals that cannot be produced by our body unlike plants that can make their own food through photosynthesis. Therefore, it is required to know the quality of our intake. There were times where food quality did not matter much as now due to its manipulation for higher yield of product as per the demands. Traditional methods of quality assessment rely heavily on manual inspections, chemical tests, and sensory evaluation, which are often time-consuming, costly, and prone to human errors.

Olden method of food detection:

This method is based on the texture and physical properties like Visual Inspection: Looking for visible signs of spoilage, damage, or contamination. Smell Test: Checking for unusual or unpleasant odours. Taste Test: Sampling food to detect off-flavors or spoilage. Texture Check: Evaluating the texture of food to detect changes or spoilage. pH Testing: Using pH strips or meters to check the acidity or alkalinity of food. Moisture Content Measurement: Determining the moisture level in food to predict shelf life. Microbiological Testing: Using traditional culturing methods to detect microorganisms.

Scientific methods:

The techniques are precise however they are not as accurate as expected and energy consuming with high expense. Chromatography: Separates and identifies components of food to detect contaminants or adulterants. Spectroscopy: Analyses the interaction between matter and electromagnetic radiation to detect changes in food composition. PCR (Polymerase Chain Reaction): Amplifies DNA sequences to detect specific microorganisms or contaminants. ELISA (Enzyme-Linked Immunosorbent Assay): Detects specific proteins or antibodies to identify contaminants or allergens. Mass Spectrometry: Identifies and quantifies molecules in food to detect contaminants or adulterants. Microscopy: Uses light or electron microscopy to detect microorganisms, contaminants, or structural changes in food. Therefore, paving a way for AI way of detection.

AI approach:

The use of AI an impactful analytic tool was found suitable for quality inspection of various food and agricultural products. The core of AI consists of machine learning and deep learning. Machine learning is widely used in the quality inspection of food products, especially for classification and predictive modelling such as partial least squares (PLS), support vector machine (SVM), artificial neural network (ANN), k-nearest neighbour (kNN), and random forest. Machine learning algorithms provided better performance as compared to other techniques in the fruit classification according to the respective maturity stages. On the other hand, deep learning has also gained attention in quality evaluation of food attributes due to the ability of learning data representation. ANN is the most widely applied for research purposes as it delivers high precision in terms of accuracy and rapid observation for the quality detection of food and agricultural products. Therefore, the use of AI in the quality inspection of food and agricultural products provides the advantages of convenient operation as well as to improve productivity in the food-related areas and supply chain.

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EMERGING CHEMISTRY

CHEMISTRY IN BIOPLASTIC RESEARCH

E. AKSHIYA

I M. Sc.

INTRODUCTION

Plastics are an integral part of modern life, yet their persistence in the environment has created a global waste crisis. Conventional plastics are made from petroleum-based polymers that resist degradation, leading to pollution and ecological harm. In response, bioplastic research has gained momentum as a sustainable alternative. The role of chemistry is central in this field—both in understanding the properties of natural polymers and in designing new biodegradable materials.

1. What Are Bioplastics?

Bioplastics are a broad class of materials derived from renewable biological sources such as corn starch, sugarcane, cellulose, and even microorganisms. Unlike conventional plastics, many bioplastics are biodegradable or compostable, meaning they can break down naturally under the action of microbes. Chemically, bioplastics are made up of polymers, but their monomeric units come from natural feedstocks instead of fossil fuels.

2. Polymer Chemistry in Bioplastics

The foundation of bioplastic research is polymer chemistry. Natural monomers such as lactic acid, hydroxybutyrate, and glucose can undergo polymerization reactions to form long-chain macromolecules with desirable mechanical and thermal properties.

Polylactic acid (PLA): Produced by the polymerization of lactic acid derived from fermentation of sugars. It is transparent, strong, and widely used in packaging.

Polyhydroxyalkanoates (PHA): Synthesized by microorganisms as intracellular carbon storage. PHA has excellent biodegradability and is being explored for medical implants.

Starch-based plastics: Made by plasticizing starch with glycerol or other additives, offering cost-effectiveness but with limited water resistance.

Chemists work to improve these polymers through copolymerization, blending, and chemical modification to balance strength, flexibility, and biodegradability.

3. Role of Green Chemistry

Bioplastic research is deeply connected to the principles of green chemistry, which aims to reduce environmental hazards. Green chemistry ensures that the synthesis of bioplastics minimizes the use of toxic catalysts, solvents, and byproducts. Enzymatic catalysis, fermentation, and solvent-free processes are examples of eco-friendly methods adopted in bioplastic production.

4. Challenges in Bioplastic Chemistry

Despite their promise, bioplastics face several chemical and practical challenges:

Performance limitations: Many bioplastics lack the durability of petroleum-based plastics.

Hydrophilicity: Polymers like starch are sensitive to water, limiting their applications.

Cost and scalability: The chemical processes for producing bioplastics are often more expensive than traditional petrochemical routes.

Recycling and degradation control: Not all bioplastics degrade under natural conditions, and their recycling streams are still under development.

Chemists are addressing these issues by developing composites, nanofillers, and chemically modified biopolymers to enhance strength, barrier properties, and controlled degradation.

5. Future Perspective

Advances in polymer chemistry, biotechnology, and materials science will continue to push the boundaries of bioplastic research. The integration of nanocellulose, lignin derivatives, and bio-based additives promises stronger and more versatile materials. Additionally, synthetic biology is enabling microorganisms to be engineered for efficient monomer production. Ultimately, chemistry will remain at the heart of designing bioplastics that are both functional and environmentally responsible.

CONCLUSION:

The chemistry of bioplastics lies at the intersection of polymer science, green chemistry, and biotechnology. By exploring new polymerization methods, renewable monomers, and sustainable processes, chemists are paving the way toward eco-friendly materials that can replace conventional plastics in many sectors. Bioplastic research is not just a scientific challenge but also a key step toward a cleaner and more sustainable future.

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CHEMISTRY IN SPACE

S. VISHNUPRIYA

I M.Sc

Introduction

Chemistry in space is one of the most fascinating fields of modern science, as it brings together chemistry, physics, astronomy, and even biology to explain how matter behaves beyond Earth. At first glance, space may seem like a completely empty vacuum, but it is actually filled with gases, dust particles, plasma, and high levels of radiation. These materials interact under extreme conditions of temperature and pressure to produce chemical reactions that are very different from those on Earth. Studying these processes helps scientists understand the formation of stars, planets, and galaxies, as well as the possible origin of life itself. At the same time, chemistry also plays an important role in human space exploration, as it is used in rocket propulsion, astronaut life-support systems, and the analysis of other planets and celestial bodies. In this way, chemistry in space is not just about theory but also about practical applications that make space travel and research possible.

Chemistry of the Universe

The universe is mostly made up of simple elements, primarily hydrogen and helium, which together make up more than 99% of all known matter. These elements, under the influence of gravity and extreme heat, combine in stars to form heavier elements such as carbon, oxygen, and nitrogen through nuclear fusion processes. These heavier elements are the building blocks of more complex molecules that are necessary for the formation of planets and eventually for life. For example, water (H_2O), methane (CH_4), ammonia (NH_3), and carbon dioxide (CO_2) have been detected in interstellar clouds and on the surfaces of comets and asteroids. These molecules are formed under extreme conditions of very low temperatures, high radiation, and strong magnetic fields that are present in space. Interestingly, many of these molecules are also essential for life on Earth. Therefore, studying the chemistry of the universe not only helps us understand how stars and planets are formed but also provides clues about how life may have originated.

Rocket Propulsion

One of the greatest achievements of chemistry in space exploration is the development of rocket propulsion systems. Rocket propulsion is the use of chemical reactions between a fuel and an oxidizer to produce a large amount of energy in the form of thrust, which allows rockets to escape Earth's gravity. For example, the most common rocket fuel is liquid hydrogen, which reacts with liquid oxygen to form water vapor and release a tremendous amount of energy. This type of chemical reaction is highly efficient and provides the power needed for launching satellites, sending astronauts into space, and carrying out interplanetary missions. Without chemistry, the design of fuels, oxidizers, and combustion processes for rockets would not be possible. Moreover, advanced research in chemistry is now leading to the development of more eco-friendly fuels, solid propellants, and hybrid propulsion systems, which are expected to make space travel safer, cheaper, and more sustainable in the future.

Life Support in Space

Human survival in space would be impossible without chemistry. Astronauts live in a very hostile environment where there is no oxygen to breathe, no water to drink, and no natural way to grow food. Life-support systems inside spacecraft and space stations are designed using chemical principles to provide astronauts with the essentials they need. Oxygen is either carried in tanks or generated by chemical reactions such as the electrolysis of water. Carbon dioxide, which is harmful in high concentrations, is removed from the spacecraft's atmosphere using compounds like lithium hydroxide that chemically absorb CO_2. Similarly, water is purified and recycled using advanced chemical filtration and purification systems to ensure astronauts always have a fresh supply. Even food that astronauts eat is preserved, packaged, and processed using chemical methods to make sure it lasts longer in space. In addition, protective spacesuits and spacecraft shielding are designed with special chemical materials that can withstand extreme temperatures and harmful radiation. In this way, chemistry directly supports human survival in space.

Studying Planets and Stars

Another important application of chemistry in space is the study of distant planets and stars. Since humans cannot directly visit most of these celestial bodies, scientists use a powerful technique called spectroscopy to study them. Spectroscopy is based on the principle that every element and compound absorbs or emits light at specific wavelengths. By analysing the light coming from a star or planet, scientists can determine what chemicals are present in its atmosphere or on its surface. This method has already revealed the presence of water vapor, methane, carbon dioxide, and even oxygen in the atmospheres of certain exoplanets. The discovery of such chemicals is very important because they are often linked to the possibility of life. Chemistry therefore acts as a tool for astronomers to search for habitable planets beyond our solar system and to understand the physical and chemical nature of stars, galaxies, and nebulae.

Astrochemistry

Astrochemistry is a special branch of science that combines astronomy and chemistry to study the formation and behavior of molecules in space. It deals with questions such as: How do molecules form in interstellar clouds where temperatures are close to absolute zero? How can complex organic molecules, such as amino acids, survive in the harsh radiation of space? And could these molecules have been the origin of life on Earth? Researchers have discovered that simple molecules like hydrogen (H_2), carbon monoxide (CO), and ammonia (NH_3) can form in space and then combine into more complex organic compounds. Interestingly, some meteorites that have landed on earth contain amino acids and organic compounds, suggesting that the essential ingredients for life may have come from outer space. This has led to the theory that life on Earth may have been "seeded" from space through comets and asteroids, a concept known as panspermia. Astrochemistry, therefore, plays a vital role in answering some of the most important questions about the origin of life and the possibility of extraterrestrial organisms.

Conclusion

Chemistry in space is a vast and important field of study that connects the smallest particles with the largest cosmic structures. From understanding the birth of stars and planets to ensuring the survival of astronauts, chemistry is everywhere in space science. It makes space exploration possible through rocket fuels and life-support systems, and it allows scientists to detect and study chemical signatures on distant planets. Astrochemistry even provides clues about the origin of life and the possibility of its existence beyond Earth. Without chemistry, our knowledge of the universe would be extremely limited, and space exploration would remain an impossible dream. As we continue to explore the cosmos, chemistry will remain at the heart of every discovery and achievement in space science.

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ROLE OF CHEMISTRY IN VACCINE

S VANITHA

III B. Sc.

VACCINE

A vaccine is a biological preparation that helps the body develop immunity to a specific disease.

For innovation of a vaccines, we need to say thanks to field of biotechnology and chemistry. They introduce a modified or "imitation" version of a disease like polio or measles to a person's immune system, the body is able to recognize and fight off future exposure to the disease, resulting in reduced severity of symptoms. As a result, vaccine-induced immunity works with the body's natural defenses to help it resist and overcome disease.

But why are chemicals added to vaccine ingredients?

- Chemical ingredients are added to vaccines for a variety of purposes – for e.g.: some are added to inactivate a virus or bacteria and stabilize the vaccine, while others are added to preserve the vaccine efficiency, preventing the vaccine from losing its potential over time.
- It is very important to review the ingredients in vaccines with your doctor to avoid any possible vaccine allergens. For example, some individuals may have an allergy to egg protein which can be found in most flu vaccines. By Discussing your individual needs with a healthcare professional, you can prevent unnecessary and unpleasant vaccine side effects.

Common Ingredients in Vaccines:

* **Aluminium gels/sol**

The most common chemical element present in nature, air, food and water is aluminium. **It** is the third most abundant element in earth. Tiny amounts of aluminium are added to some vaccine help the body to build stronger immunity against the infective disease eg: viral disease. Additives of aluminium are used in vaccines for viral disease such as hepatitis A, hepatitis B, and diphtheria-tetanus-containing vaccines, among others. Often Health officials used to recommend these vaccines for babies and young children, which may sometimes lead parents to ask question for the safety of aluminium in the vaccine. But babies already have a small amount naturally occurring aluminium in their bloodstreams, about 5 nanograms (a nanogram is equal to one billionth of a gram) from infant formula or breast milk from mother feeding. The amount of aluminium in a vaccine is lower than aluminium naturally present in babies. According to the report produced by FDA, vaccines containing aluminium have a demonstrated safety profile based on more than six decades of use and are only rarely associated with vaccine less side effects, such as skin irritation or swelling.

* **Formaldehyde and other preservatives**:

Small amounts of formaldehyde have long been used in manufacturing of viral and bacterial vaccines. It is a amazing fact, that formaldehyde is found everywhere, our bodies produce it, and we even exhale minimum concentrations of formaldehyde in our breath. The amount of formaldehyde present in some vaccines is very small compared to the concentration that occurs naturally in the body that it does not pose a safety concern. In vaccines, formaldehyde is used for inactivating a virus before it can cause the disease the person is being vaccinated against (for example, the polio virus used to make polio vaccine) and to detoxify bacterial toxins, such as the toxin used to make the diphtheria vaccine. It is a common vaccine preservative added to some vaccines to prevent the growth of bacteria or fungi that could be introduced into the vaccine during actual vaccination.

* **Sugars and other stabilizers**:

Some stabilizers are added to help the vaccine to maintain its effectiveness during storage and transit. Sugar also added as stabilizer. Vaccines are imported and exported all over the world; it's very important that they work when needed, and don't degrade or lose effectiveness during the heat and cold of import and export. Some other stabilizers are also added to vaccines for example lactose and amino acids such as glycine or the monosodium salt of glutamic acid, and proteins such as human serum albumin or gelatin.

Conclusion:

Vaccines are those wonder medicinal discoveries, which has improvised the pathological conditions, eradicated the chronic diseases, enhanced human longevity. For synthesis of the vaccine molecules, knowledge of chemistry is essential. Fabrication of the vaccines, which is essential in effective delivery of them, it is important to understand the chemistry between vaccine and constituents of blood and other bodily fluids.

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ROLE OF GREEN CHEMISTRY IN SUSTAINABLE DEVELOPMENT

KAVITHA D.

I M.Sc.

INTRODUCTION:

Sustainable development has become one of the greatest challenges of the 21st century, demanding innovative approaches that balance economic growth, environmental protection, and societal well-being. At the core of this transformation lies green chemistry, also known as sustainable chemistry. Green chemistry focuses on designing chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Unlike traditional chemistry, green chemistry integrates safety, efficiency, and sustainability from the very beginning of product design. By applying the 12 principles of green chemistry—such as atom economy, renewable feedstocks, energy efficiency, and design for degradation—scientists and industries are shaping a future where chemistry contributes directly to sustainability goals.

Challenges with Conventional Chemistry

Traditional chemical industries relied heavily on non-renewable raw materials, toxic solvents, and energy-intensive processes. These methods often generated large amounts of hazardous waste, polluted air and water, and consumed excessive fossil fuels. For instance, the use of chlorinated solvents in industrial cleaning or heavy metals in catalysis caused long-term damage to ecosystems and human health. Such practices were not only environmentally harmful but also economically costly, requiring significant investments in waste treatment and environmental remediation. The urgent need for safer, cleaner, and more resource-efficient alternatives gave rise to the philosophy of green chemistry.

Green Chemistry as a Path to Sustainability

Green chemistry has opened new possibilities by promoting safer materials, renewable energy sources, and eco-friendly chemical reactions. From biodegradable plastics to non-toxic paints and detergents, innovations are now aligned with the principles of sustainability. For students and scientists, green chemistry offers a hands-on, problem-solving approach that connects science with global challenges like climate change, pollution control, and resource conservation. Educational platforms and research programs worldwide now emphasize the role of green chemistry in shaping future industries. This ensures that the next generation of chemists is not only skilled in science but also trained to design solutions with environmental and societal responsibility.

Applications of Green Chemistry in Sustainable Development

- **Cleaner Energy Solutions:** Development of biofuels, hydrogen energy, and solar cells using non-toxic materials reduces dependence on fossil fuels while lowering greenhouse gas emissions.
- **Eco-Friendly Industrial Processes:** Catalysts designed through green chemistry principles minimize waste and energy consumption in industries such as pharmaceuticals, polymers, and agriculture.

- **Biodegradable and Renewable Materials:** From packaging made of starch-based polymers to biodegradable plastics, green chemistry enables the creation of sustainable alternatives that reduce plastic pollution.
- **Water and Waste Management:** Green chemistry provides innovative methods for water purification, recycling of industrial waste, and designing chemicals that degrade safely without harming ecosystems.

CONCLUSION:

The role of green chemistry in sustainable development goes far beyond scientific innovation—it represents a commitment to preserving the planet for future generations. By designing chemical processes that minimize harm and maximize efficiency, green chemistry transforms industries into engines of sustainability.

As society faces challenges such as climate change, resource scarcity, and environmental degradation, green chemistry stands as a guiding force. For scientists, it offers an opportunity to create sustainable technologies; for industries, it reduces costs while protecting the environment; and for society at large, it ensures a healthier, safer, and greener future.

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CHEMPUZZLES

CHEM RIDDLES

LOGESHWARI & TEJASHWINI G.

III - B.Sc

1. I am oxidane, I am used by everyone, everywhere. Who am I?

2. I am the Swedish god of beauty and fertility; I am very soft and ductile and I exist in various colours in various forms. Who am I?

3. In certain languages WATER is written as XBUFS. How is OXYGEN denoted in that code?

4. If H_2O is the formula for water, what is the formula for ice?

5. What is lighter than what it is made up of?

6. I am least soluble and precipitated first. I react with acetic acid and K_2CrO_4. I form yellow precipitate. Who am I?

7. I am before the inert gas elements. I am pale yellow with faint smell. Who am I?

8. Why is ethene seen as a drunkard after visiting a friend?

9. After returning from yoga class Zn became ZnO. What kind of reaction is taking place?

10. V is crossing 4 buildings towards east, 4 buildings towards south, 2 buildings towards north and 2 buildings towards east to meet______?

ANSWERS:

1. Water
2. Vanadium
3. PYZHFO
4. H_2O
5. Bubble
6. Lead
7. Fluorine
8. Because it “drank” water and turned into ethanol!
9. Oxidation
10. Mercury

CHEM RIDDLES

KUMUTHA M
II B. Sc

1. I'm not alone, I come in groups holding hands, we form some troops. What am I?
2. I change the structure where I play, creating new things day by day what am I?
3. What animal is made up of Calcium, Nickel and Neon?
4. Diamonds and stress have this to thank for their existence?
5. In a green factory, I am the king; no light escapes my walking ring. what am I?
6. What would you call a clown in jail?
7. I'm a God, a planet and a measurer of heat. Who am I?
8. I can keep a swimming pool clean, but I can poison you as well. What am I?
9. I turn purple black when iodine is added to me?
10. I may have twice the life-giving gas but I do not give life to you. Absence of me, makes your food unavailable. What am I?

ANSWERS:

1. Molecule
2. Reaction
3. CaNiNe
4. Pressure
5. Chlorophyll
6. Silicon
7. Mercury
8. Chlorine
9. Starch
10. Carbon dioxide

CHEMISTRY CONUNDRUM

DHARSHENI R.

III B.Sc

1. I am present in marshes and also in cattle rumen to stop global warming. I do very little. What am I?
2. I am essential to life on earth! Iam split into thirds. Two thirds are the same. One of the third is 8. The other two are one each. What am I?
3. I am black when you buy me, red when you use me. When I turn white, you know it's time to throw me away. What am I?
4. Shiny like silver, denser than lead, pricier than gold, could stop a bullet, if I wanted to you. What am I?
5. I may not be gold but I make gold look more beautiful. I help you fly and even though I am not popular, my price runs high. What am I?
6. Yellow in colour, I can be a laboratory risk, you'll most often find me used in an explosive. What am I?
7. I may be twice the life-giving gas but I do not give life to you. However, without me, you will never have food. What am I?
8. You can get me for free, but inside an atom. I add a lot of weight. What am I?
9. I can keep a swimming pool clean, but I can poison you as well. What I am?
10. This can be used to flatten clothes or in golf to hit a ball, this goes before a movie man and is a type of metal. What is it?

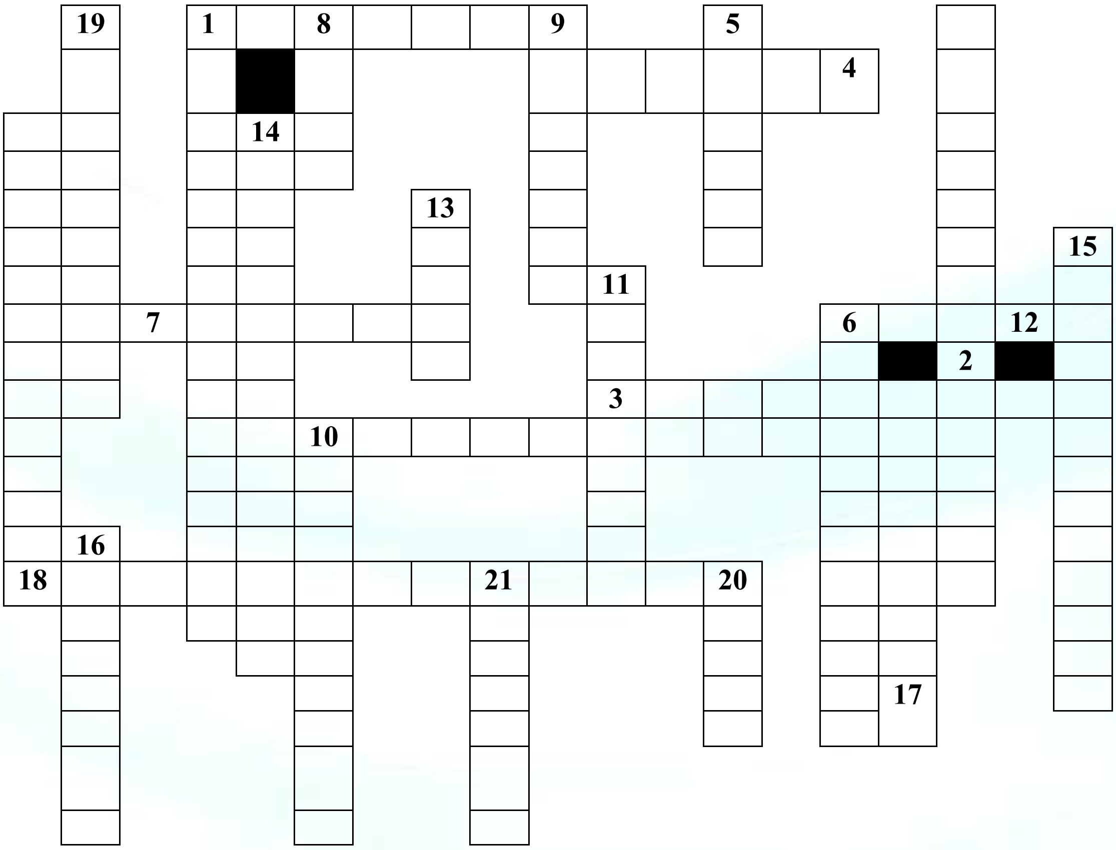
ANSWERS

1. Methane gas
2. Water
3. Charcoal
4. Osmium
5. Rhodium
6. Nitric acid
7. Carbon dioxide
8. Neutron – because it has no charge
9. Chlorine
10. Iron

CROSSWORD PUZZLE

THINK LIKE A CHEMIST!

SHANMUGAPRIYA B.
II – B.Sc.



ACROSS:
1. Its IUPAC name is Propane (7)
3. A mineral consisting of lead Carbonate, $PbCO_3$ (9)
4. The main component in the Cell wall of Fungi (6)
7. Less Concentrated (6)
9. It is a measure of degree of disorder of a system (7)
10. Ion detection by flame color (9)
12. Process used for the extraction of Ni -______'s process (4)
14. pH indicator turning pink in base (15)
16. A mixture of CO + H_2 (8)
18. Used to identify the end amino acid in a protein (13)

DOWN:
1. The minimum amount of energy required to cause a chemical reaction (16)
2. A Silvery white metal with reddish tinge which belongs to V group of periodic table (7)
5. A pale Yellow oily liquid with a pleasant odor of lemon (6)
6. A method employed to purify a liquid (12)
8. Compound containing the group -CH=C (OH) (4)
10. An atom with single unpaired electron (11)
11. Sweetest of all sugars (8)
13. Process for manufacture of ammonia- ________'s process (5)

15. A synthetic radioactive transactinide element Z=104 (13)
19. Molecule with both positive and negative charges (10)
20. An Aluminium Silicate mineral that is commonly used as a gemstone (5)
21. An alloy of Mercury with other metals (7)

UP:

2. The angle between two bonds (9)
17. A green patina of basic copper salts formed on copper (9)
18. Process of forming stable co-ordinate complexes (13)

ANSWERS

ACROSS	DOWN	UP
1. Acetone	1. Activation Energy	2. Bond angle
3. Cerussite	2. Bismuth	17. Verdigris
4. Chitin	5. Citral	18. Sequestration
7. Dilute	6. Distillation	
9. Entropy	8. Enol	
10. Flame Test	10. Free Radical	
12. Mond	11. Fructose	
14. Phenolphthalein	13. Haber	
16. Water Gas	15. Rutherfordium	
	19. Zwitter ion	
	20. Topaz	
	21. Amalgam	

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