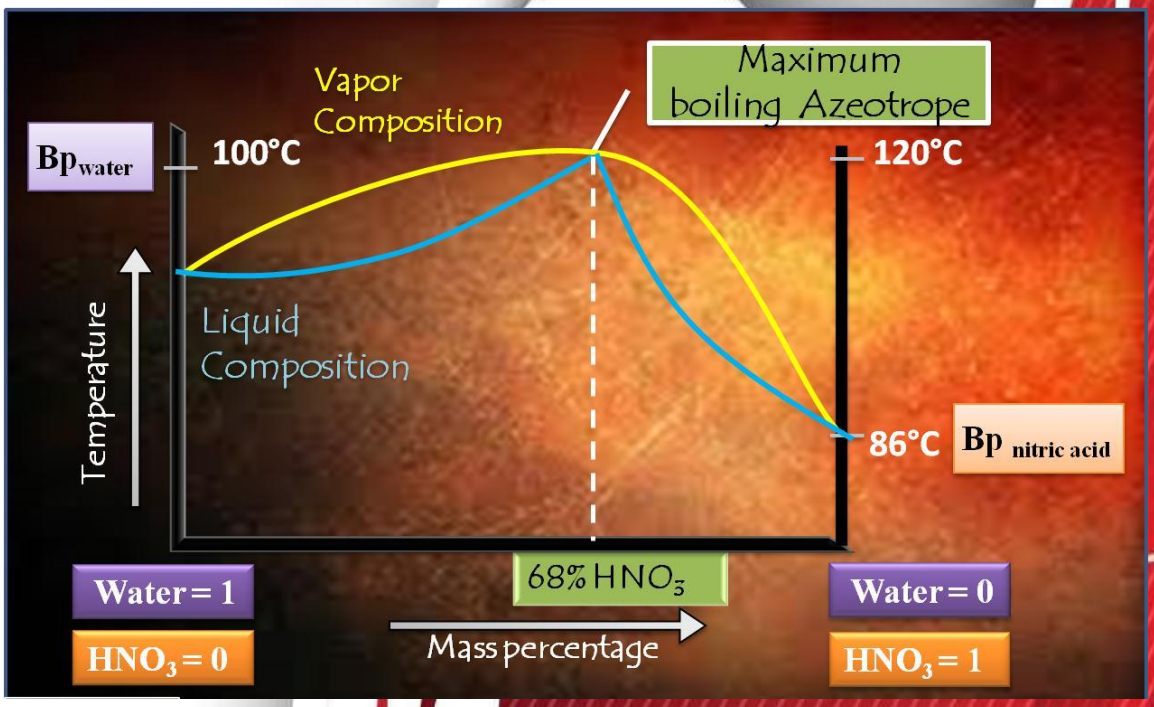
AZEOTROPE

VOLUME – 3 (2021)



DEPARTMENT OF CHEMISTRY
CENTRAL UNIVERSITY OF TAMIL NADU
THIRUVARUR – 610 005

Editorial

The Department of chemistry, Central University Tamil Nadu, is pleased to introduce a Magazine called "Azeotrope". This is basically a chemistry Magazine, where one can find various aspects of chemistry. What does Azeotrope means actually? It is a mixture of liquids with constant boiling point at all composition, one cannot separate this mixture of liquids by fractional distillation. Similarly, chemistry is something that we breath, drink, eat, see, what and what not in day to day life, it is difficult to separate chemistry from the nature, so the name "Azeotrope" could be the better choice for this chemistry magazine.

In this magazine, the students of chemistry, Central University Tamil Nadu have discussed about various interesting facts of chemistry that are found in nature, science and technology. First of all, we thanks all the students for their valuable contribution to the magazine.

Azeotrope is briefly about how the chemistry plays a role behind all these discovery/development in each articles. Azeotrope will give thought provoking articles from the basic to advanced level of research in chemistry. By reading this magazine one will get an idea of what is happening in and around us on the basis of chemistry. If you find boring on reading articles, we do have poem by some creative poet and also a puzzle to keep your mind active to test your intellect. Go ahead with the Azeotrope.

We welcome you for any suggestion and contribution for the betterment of the Azeotrope for this and forthcoming editions.

Editorial Team members
Department of Chemistry, CUTN

Editorial Board Members

Foreword

Chemistry is a branch of science that has been around us for very long period. In fact, chemistry is known to date back to as the prehistoric times. Due to the amount of time, chemistry takes up on the timeline, the science is split into four general chronological categories. The four categories are: prehistoric times – beginning of the Christian era (black magic), beginning of the Christian era – end of 17^{th} century (alchemy), end of 17^{th} century – mid 19^{th} century (traditional chemistry) and mid 19^{th} century – present (modern chemistry). However, the modern chemistry aims to promote rapid communication and dialogue among the researchers, scientists, engineers and policy makers working in the area of science in general and particularly chemistry in the world. "Azeotrope" magazine provides a mix of articles, related to basic and modern chemistry from essential news, research discoveries, day-to-day life, puzzle and poem through to thought-provoking features. It also includes the importance of natural products, energy and cost effective batteries, graphene and carbon nanotubes in nanoscience and nanotechnology and also chemistry behind our food. This magazine consists of articles, poem and puzzle which were exploited by the IMSc and MSc Students of the Department of Chemistry, Central University of Tamil Nadu. Exploration and bringing up of student skills like innovative ideas of research, sharing their knowledge in chemistry, writing poems and creating puzzles is the main aim of this Azeotrope magazine.

T. Mohan Das
Professor & Head,
Department of Chemistry

From the Desk of the Head

Greeting from the Department of Chemistry, Central University of Tamil Nadu, Thiruvarur!!! As we all know, the world is going through a tremendous transformations in education and research and its impacts are clearly discernible. We, the department of chemistry would like to be part of this positive changes by utilizing our core strength. Our journey started way back in 2009, when the university was established. Starting from the year 2009, the department began the IMSc course with other courses added at different period, established world class laboratory with good instrumental facilities etc., All these achievements of the department would not have been possible without the enthusiastic and dedicated work of my fellow colleagues. Department of chemistry faculty members are exceptionally dedicated set of teachers and at the same time excellent researchers in their field of study publishing on regular intervals in well reputed journals. We are supremely confident that in coming years, department with its rigorous and regularly updated syllabus, research and active participation in various academic activities will enforce the reputation.

Articles

1

The Future Is Flexible By Flex Circuits

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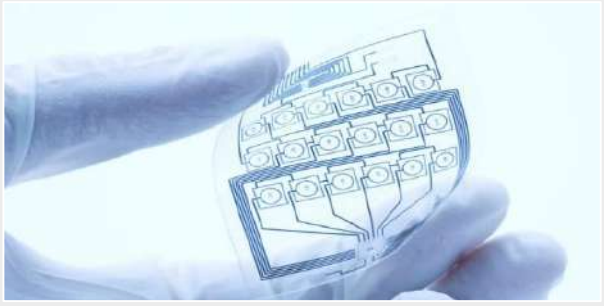
Imagine that you can wrap your mobile phone around your wrist or rollout a screen from it so that you can watch full colour television, a movie, read a book or a newspaper. Imagine a portable rolled out television that can be stick on the window like a wallpaper. All over the globe, researchers are working hard to realise electronic devices that can flex, roll or bend giving rise to an electronics era, which is popularly called 'Flexible electronics'.

Flexible electronics isn't a new technology, but it has achieved a remarkable progress over the past years. It is a technology that allows you to build electronic circuits on flexible substrates thus making them bendable and stretchable. It enables new product paradigms that aren't possible with conventional semiconductors and glass substrates.



Silicon technology has been the main driving force behind miniaturizing devices to reduce costs while improving its performance. The material rigidity of silicon is an impasse of its ubiquitous use in soft electronics applications.

PLASTIC ELECTRONICS

The substrate is fundamental for building up flexible electronics that supports and protects devices on it. Several factors(lightness, flexibility, stretch ability, insulation, etc.) ought to be considered to evaluate a substrate. Many commercial polymers have been employed as flexible substrates, including polyvinyl alcohol (PVA), Polyethylene terephthalate (PET), Polyimide (PI), poly (ethylene2, 6-naphthalenedicarboxylate) (PEN), polyethylene (PE), polyurethane (PU), polydimethylsiloxane (PDMS).

APPRECIABLE FEATURES

LIGHT AND THIN: Using a flexible substrate (instead of glass) in combination with organic transistors helps make the whole stack very thin. For example at Flex Enable we use low-cost bio-based substrates such as TAC (tri acetyl cellulose) which are just a fraction of a tenth of a millimetre thick. As a result the entire OLCD is just 0.3mm thick.

UNBREAKABLE: One property of flexible electronics which deserves to be highlighted is their robustness. This makes a great difference for applications such as wearable's, notebooks and other consumer electronics which traditionally feature glass-based displays or sensors.

In simple words, Flexible refers to the substrate which can be a broad range of film material, like PET and PI. But also, paper is becoming more and more popular, due to the environmental advantages.

PAPER ELECTRONICS

At first glance, paper might seem like an unlikely front-runner in the flexible electronics race.

At a microscopic level it's just a tangle of cellulose fibres, hardly the sort of structure that's ideal for making a bunch of finely featured, identical circuit components. It's lightweight, flexible, biodegradable, and it comes from a renewable resource. It's also extraordinarily adaptable. With the right set of additives and manufacturing processes, paper can take on a seemingly endless range of properties. It can be made hydrophilic or hydrophobic, porous or watertight, opaque or nearly transparent, delicate or strong, or about as smooth as glass.

Flexible electronics has recently attracted much attention because of their potential in providing cost-efficient solutions to large-area applications such as roll able displays and TVs, e-paper. The key advantages of them, compared with current silicon technologies, are low-cost manufacturing (e.g. ink-jet printing and roll-to-roll imprinting) and inexpensive flexible substrates (e.g. plastics).These advantages make flexible electronics an attractive candidate for next-generation consumer products which require lightweight, bendable, portable, and low-cost electronics.

Thin-film transistors (TFTs) are key elements to implement flexible circuits because of their compatibility with flexible substrates and low-cost manufacturing methods. Recent advances in thin-film technologies such as solar cell, battery, active and passive elements have made flexible electronics from a scientific fiction to a reachable reality, despite that it is still a far one.

2

Aggregation –induced emission:
the whole is more brilliant than the parts

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Aggregation induced emission refers to a photophysical phenomena shown by a group of luminogenic materials that are non emissive when they are dissolved in goodsolvents as molecules but become highly luminescent when they are clustered in poor solvents or solid state as aggregates. In the area of luminescence research, there is a notorious physical phenomenon called Aggregation caused quenching: emission from a solution of luminophore is quenched with an increase in concentration. This ACQ effect is common to most hydrocarbons and their derivatives. The ACQ effect has been a thorny obstacle to the development and casting of optoelectronic devices.

In 2001, Teng et al discovered that the luminogenic aggregation played a constructive, instead of a destructive, role in the light-emitting process: a series of siloed molecules were found to be non-luminescent in the solution state but emissive in the aggregated state. New term is coined as "aggregation-induced emission" (AIE) for this novel phenomenon, because the non-luminescent siloed molecules were induced to emit by aggregate formation.

Restricted Intramolecular rotation is the main mechanism for AIE.

A molecule shows ACQ or AIE based on its structural design. The architecture of the molecule i.e., its planarity, structural twisting, pi-pi stacking, intramolecular rotations, inter/intramolecular interactions etc., determines its aggregation behavior. Looking into the donor acceptor molecules, generally compounds with D-A or A-D architects show ACQ characters because of the easily rotatable C-C bonds. But if a pi-linker is attached between the donor and acceptor moiety to generate D-pi- A type of molecules, due to more restriction these molecules show the AIE behavior.

For a molecule to be converted from ACQ to AIE, it should be occupied with a freely rotating moiety that can disperse the energy in the excited state and secondly in the aggregate state, it should have a twisted 3D structure to avoid the pi-pi stacking.

There are many mechanisms to convert ACQphores to AIEgens.

i. Attaching AIEgens to ACQphores
ii. Displacing Part of AIEgens to ACQphores.
iii. Building new AIEgens to ACQphores by increasing the molecular motion and by introducing the non-planarity.

AIE effect have brought boundless technological innovations in the field of optoelectronic devices, biology,sensing and other tech areas.

AIEgens can be an ideal choice for an optoelectronic devices. The utilities and usage of AIEgens in OLED,OFET and OPVs are well documented in the literature. Wang et al synthesized the TPE derivatives which has good AIE properties and showed blue green fluorescent OLED.

AIEgens have been used for successful design and synthesis of sensitive biosensors and chemo sensors. Many TPE and silol based sensors are reported in the literature. Wang et al reported a silol derivative which showed good AIE character but with the addition of acid,it becomes non emissive,hence this could be used as an acid sensor.

Nitroaromatic compounds which has been used as a explosive can be easily detect with AIE based sensors. These sensors have merits like increased selectivity and sensitivity and short time response.

Zhang et al reported fused carbazole based dyads which showed carbazole based dyads which showed efficient AIE properties and these aggregates could effectively sense picric acid. AIEgens are also used for the sensing of small biogenic molecules like glucose, natural macromolecules like DNA, polysaccharides,phospholipids etc.

Other than sensing, AIE also finds application in bioimaging. An example of AIE based bio imaging is a new diketopyrrolepyrrole based derivative that was synthesized and it showed efficient.

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3

Interesting Facts

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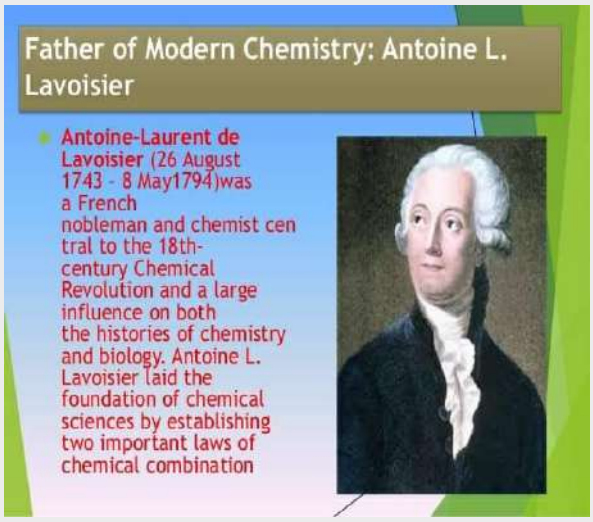

➢ Our fingers get wrinkly or pruney in water to give us stronger grip on slippery objects underwater.

➢ Human brain is around 78% water and nearly 60% fat.

➢ If the earth lost oxygen for 5 seconds all the buildings made of concrete will crumble to dust.

What if oxygen levels doubled on earth then?

➢ Lemon has more sugar content than strawberry; percentage wise as 70% and 40%

➢ Oceans produce up to 85% of oxygen on earth.

➢ Honey is the only food that does not get spoiled. When heated and strained honey is sealed properly. Moisture is not absorbed.

➢ Do you when was Cobalt Discovered?

Cobalt has been detected in Persian jewellery in Egyptian sculpture as far back as third millennium BCE. Traces have alllso been found in Pompiaen ruins. In 1735, Georg Brandt, a Swedish Chemist was credited for isolating of cobalt.

➢ By the time you feel thrist, your brain's performance is 10% reduced. We begin to feel thirst when our body loses 1% of water. Stay hydrated!

➢ Cat urine, in particular, glows very brightly under ultraviolet light. Urine glows under a black light primarily because it contains the element phosphorus. Phosphorus glows yellowish green in the presence of oxygen, with or without black light, but the light imparts additional energy that make the chemiluminescence easier to see.

Urine also contains broken down blood proteins that glow under a black light.

➢ Graphene aerogel is seven times lighter than air, can balance on a blade of grass.

➢ The earliest producing diamond mines were in the Golconda region of India. Diamonds were found only in alluvial deposits in Guntur along the rivers Penner, Krishna and Godavari in Southern India.

In 600 B.C. the Mahajanapada Empire had its own units of currency, and it's own units of measurement for diamonds.

➢ Sugar was first produced from sugarcane plants in Northern India sometime after the first century AD. The derivation of the word "sugar" is thought to be from Sanskrit शर्करा (śarkarā), meaning "ground or candied sugar," originally "grit, gravel".

➢ Sanskrit literature from ancient India, written between 1500 - 500 BC provides the first documentation of the cultivation of sugar cane and of the manufacture of sugar in the Bengal region of the Indian subcontinent.

4

Nanochemistry In Daily Life

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➢ Nanochemistry can make the most essential and effective contrast agent of MRI out of iron oxide (rust) which has the potential of detecting cancers and even killing them at their initial stages.

➢ Nanoparticles of silver are used to supply antimicrobial residences in hand washes, bandages, and as well as in socks.

➢ Zinc or titanium nanoparticles are the active and effective UV-protective factors in modern sunscreens.

➢ The contents of bathroom cabinet may also additionally include micellar or liposomal products that use nanospheres to trap dirt or deliver drugs or pores and pores and skin care.

➢ Zinc or titanium nanoparticles are the active and effective UV-protective factors in modern sunscreens.

➢ The contents of bathroom cabinet may also additionally include micellar or liposomal products that use nanospheres to trap dirt or deliver drugs or pores and pores and skin care.

➢ Carbon nanotubes are one hundred times beneficial than steel and are lighter, making them useful for sports activities equipment such as bikes or tennis racket.

➢ The common workplace worker has improved display screens on desktops, portable and handheld digital devices, and memory chips with extended density.

➢ A department of nanotechnology that goes way past microprocessors and physical storage devices and gives interesting probabilities for data storage.

5

Chemistry Behind Sunglasses

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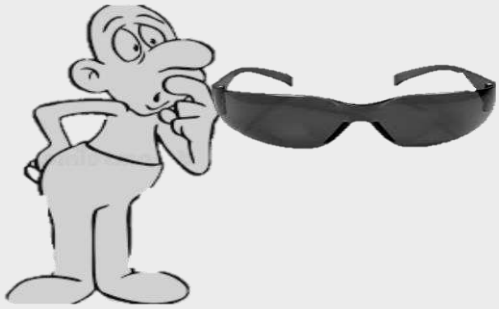
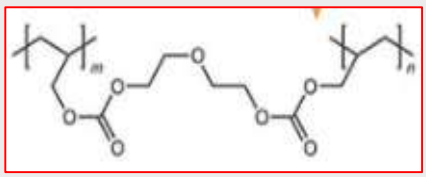
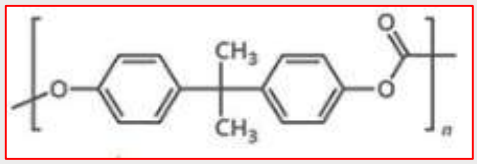
What sunglasses are made of?
How chemistry helps them to protect your eyes from the sun's ultraviolet radiations?



Sunglass manufacturers usually make lenses out of either glass or plastics such as polycarbonates or polyallyl diglycol carbonate(PADC).



PADC



Polycarbonate

Aluminium or silver coatings give lenses a mirrored look. Metal oxide coatings reduce the amount of UV radiation transmitted through the sunglasses, protecting the eyes. The oxides can also provide a coloured tint to the lenses.

PHOTOCHROMIC LENSES

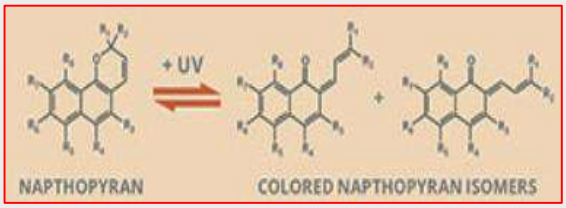
Photochromic glasses darken to a sunglasses tint when exposed to sunlight, Lenses automatically sense the intensity of light changes, absorbs theultravioletrays, the stronger the light, the darker the colour of the lens. Effectively filter the strong light, strengthen the visual definition, and keep the eyes always the most comfortable state.

REACTIONS

1. Inorganic Reactions

The silver atoms form clusters which absorb UV and visible light. Cu^{+} ions in the glass reduce the Cl atoms, stopping them from escaping.

2. Organic Reactions



Glass photochromic lenses can use copper-dopped silver halide salts that produce elemental silver in UV light, causing darkening. Plastic lenses rely on organic compounds that isomerize reversibly in UV light to produce dark tints.

6

Father Of Indian Chemistry

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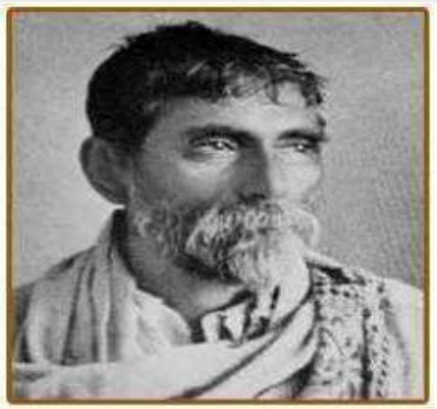
An outstanding scientist, educationalist, altruist, historian, and industrialist, Prafulla Chandra Ray has been famed for his huge contributions in several fields.



Sir Praffula Chandra Ray

Prafulla Chandra was born on August 2nd, 1861, P.C Ray has been known to be one eminint temperament whose works and discoveries are mostly related with chemistry.(organic, inorganic, or the history of chemistry).

Alexander Peddler who was among the earliest research chemists created a zeal in Ray to explore a lot in chemistry. Ray developed such a curiosity that he had set up a laboratory in his House. He had set to create a professional career out of chemistry.He was selected for a BA degree at the University of Calcutta. Prafulla wrote the test for Gilchrist scholarship

which is offered by Edinburgh University. Successfully he have cracked it. Ray started his research in double salt and researched metal double sulfates. His thesis "Conjugated Sulphates of the Copper-magnesium Group: A Study of Isomorphous Mixtures and Molecular Combinations“ has selected as best thesis in that year. He was awarded the Hope Prize this allowed him to carry the research further He was selected as a vice president for chemical society which is rare for students coming from country like India.

In 1896, he discovered the formation of mercurous nitrate which laid path for a number of investigative papers on nitrites and hyponitrites of different metals, and on nitrites of ammonia and organic amines. He made himself as the Master of Nitrites. In 1912 after his vigorous research on ammonium nitrites, he was able to prove that pure ammonium nitrite is stable. His discovery of mercurous nitrites and preparation of ammonium nitrite and his research on thiols and thioethers with metals and mono fluro acetone were published in journals like nature and journal of royal society.

His contribution in finding history of chemistry in India is very eminent.His gist of research is written in his book "The history of Hindu Chemistry". acknowledging about how our ancient India has knowledge of acids ,alkali, metallurgy and medicine.He also mentioned that due to caste system and many other reasons India didn't show any further progress. To make India self reliant for medicines there is a dire need for the pharmaceutical industry

So he came up with the idea of setting a small laboratory at his home and spending his savings he was successful in getting fruitful results and He was instrumental in creating "Bengal chemical and pharmaceutical works". Later it became the largest chemicals manufacturers in India. He set up many industries using his scientific knowledge and enthusiasm. He started the School of Chemistry .His teaching effectiveness reflectd in his students achievements, Jnan Chandra Ghosh(Director of IISc Bangalore), Panchananniyogi (founding principal of Raja Mahendrachandar college , Calcutta) and many others. He published a total of 150 research papers in outstanding journals. He also published "Life and Experience of a Bengali chemist" and dedicated to the youth. He deserves the title father of Indian chemistry.

He Strongly believes that students who have strong desire to invent something should come into the field of research but not for job security and earnings. India owes gratitude for his contributions and discoveries along with his intense passion for expanding the Indian field of science in national and international level.

P. C. Ray working in the laboratory

The way to pay tribute to this eminent person is follow his path. In developing as a man in its entirety, character and activities, committed to the cause of science, knowledge, people and society.

7

Nobel Laureates In Chemistry 2021

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David Macmillan

David William Cross MacMillan(born on 16 March 1968) is a Scottish chemist and the James S. McDonnell Distinguished University Professor of Chemistry at Princeton University. He shared the 2021 Nobel Prize in Chemistry with Benjamin List "for the development of asymmetric organocatalysis ". He received his undergraduate degree in chemistry at the University of Glasgow. where he worked with Ernie Colvin. During his doctoral studies, he focused on the development of new reaction methodology directed toward the stereocontrolled formation of bicyclic tetrahydrofurans. His postdoctoral studies centered on enantioselective catalysis, in particular, the design and development of Sn(II) derived bisoxazoline complexes (Sn(II)box). He is considered to be one of the founders of organocatalysis. He developed catalysts that can drive asymmetric catalysis, in which a reaction produces more of the left-handed version of a molecule than the right-handed one (chirality), or vice versa.He developed chiral imidazolidinone catalysts.

MacMillan catalysts [de] are used in various asymmetric syntheses. Examples include Diels-Alder reactions, 1,3-dipolar cycloadditions, Friedel-Crafts alkylations or Michael additions.

MacMillan has also extensively developed photo-redox catalysis for use in organic synthesis.

Benjamin List

Benjamin List is a German chemist(born 11 January 1968) who is one of the directors of the Max Planck Institute for Coal Research and professor of organic chemistry at the University of Cologne. He co-developed organocatalysis, a method of accelerating chemical reactions and making them more efficient. The list obtained his Diploma (M.Sc.) degree in chemistry from the Free University of Berlin in 1993, and his Ph.D. from Goethe University Frankfurt in 1997. His doctoral dissertation was titled Syntheseeines Vitamin B 12 Semicorrins (Synthesis of a vitamin B 12 semicorrin) and was advised by Johann Mulzer. In 2003 he returned to Germany to become a group leader at the Max Planck Institute for Coal Research. and in 2005 he became one of the institute's directors, heading the Homogeneous Catalysis Department.

The list is considered to be one of the founders of organocatalysis, which uses non-metal and non-enzyme catalysts. While being an assistant professor he discovered the possibility of using the amino acid proline as an efficient chiral catalyst. This takes place in inter-molecular aldol reactions, in which carbon atoms from two different molecules are bonded together, induced by proline. The development is based on the Hajos–Parrish–Eder–Sauer–Wiechert reaction. He developed the first proline-catalyzed Mannich, Michael, and α-amination reactions.

He found asymmetric catalysis (especially Asymmetric counteranion-directed catalysis, ACDC).

He developed also new methods of textile organic catalysis, in which soluble organic catalysts and textiles are bound. These methods could, for example, help to treat water where there is no freshwater. Asymmetric organocatalysis is particularly important in bio-active organic compounds, where the chirality of the compounds is important, for example in drug production.

8

The Chemical Reaction That Feeds The World

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What would you say is the most vital discovery made within the past few centuries? Numerous human-friendly technologies would come to our mind, but I would say that it is a chemical reaction! It has been called one of the best inventions of the 20th century, and without it, almost half the world's population wouldn't be alive today. This is the HABER-BOSCH PROCESS of binding the nitrogen molecules in the air to hydrogen molecules or turning air into fertilizer.

Nitrogen is an essential nutrient for plants to survive, as it forms the main component of chlorophyll and amino acids, the building blocks of protein. Without proteins, plants wither and die. As crops grow, they consume the nitrogen removing it from the soil.

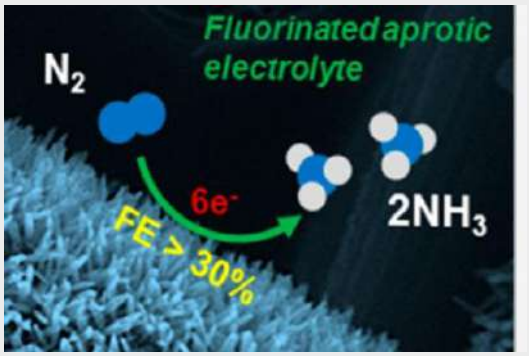
The nitrogen can be replenished through long fertilization processes like decaying animals, but humans want to grow much faster than that. An obvious source of nitrogen (N2) was the Earth's atmosphere. However, nitrogen is exceptionally stable as it has strong triple bonds: it will not react readily with other substances therefore production of ammonia directly from nitrogen represented a serious challenge.

In 1908, the German Chemist Fritz Haber found a chemical method that took nitrogen in the air and bonded it to hydrogen to form ammonia. Carl Bosch, the German chemist was given the task of scaling up Haber's reaction many times over to the industrial level. To make large amounts of ammonia quickly and easily Haber followed Le-Chatlier's principle if a system at equilibrium is subjected to a disturbance or stress, then the equilibrium shifts in the direction to nullify the effect of the disturbance or stress.

By this Haber studied the effects of pressure, temperature, and catalysts on the process and located that iron can be used as a catalyst for the forward reaction to being faster because to break strong triple bonds of nitrogen.

Today ammonia is one of the most produced chemical compounds in the world. Roughly 176 million metric tons are produced in a year. 80% of ammonia is used in fertilizer production, while the rest is used in industrial and household cleaners and to produce other nitrogen compounds, such as nitric acid. Recent studies have found that half of the nitrogen is not assimilated by plants. Consequently, nitrogen is found as a volatile chemical compound in the Earth's water supplies and atmosphere, its energy demands result in a massive carbon footprint as we get Hydrogen used in the process comes from methane (CH_4) obtained from fossil fuels (natural gas, coal, and oil) through processes that release CO_2, severely damaging our environment.

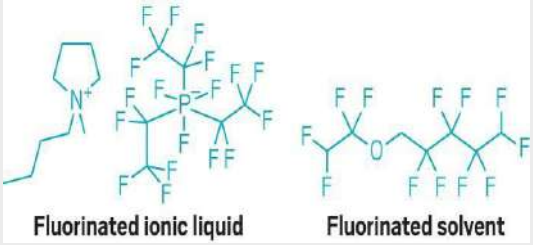
Of course, Haber did not predict this problem when he introduced his invention. Following his pioneering vision, scientists today are looking for a new Haber process of the 21st century, which will reach the same level of aid without dangerous consequences.



An electrochemical system that figures on a hydrophobic fluorinated aprotic electrolyte could pave the way to a more sustainable form of ammonia production. Why this unusual electrolyte is used? During electrochemical N2 reduction reaction (NRR) at ambient conditions, the electrochemical cells struggled with low yield rate and selectivity because nitrogen is not very soluble in water, so protons in the aqueous electrolyte are reduced to hydrogen gas instead.

Design that overcame this issue! Surface area enhanced α- Fe nanorods due to its low affinity for protons, grown on carbon fiber paper were used as NRR cathodes in an aprotic fluorinated solvent because it is lowering the electrolyte's viscosity while still retaining high nitrogen solubility and limiting proton reduction.

The ionic liquid is used so that it doesn't crystallize at ambient conditions and exists in liquid form. Through this design, significantly enhanced NRR activity with an NH3 yield rate of ~2.35 x 10-11 mol s-1 cmGSA-2 and selectivity of ~32% has been achieved under ambient conditions.



This shows that the utilization of hydrophobic fluorinated aprotic electrolyte effectively limits the supply of protons and suppresses the Hydrogen evolution reaction.

Therefore, designing the electrode and electrolyte is important in advancing renewable energy-driven ammonia electrosynthesis.

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8

Chemistry Of Emotions

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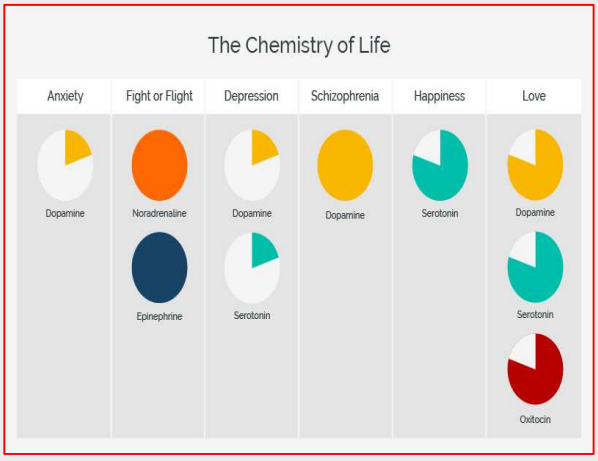
Today I wanted to introduce you to your happy chemicals, an incredible framework for understanding happiness. The science of happiness tells us that happiness, like most of our emotions, is simply the result of releasing happiness-related chemicals into your brain. Each of these chemicals is released in response to different emotional states. Neurotransmitters are chemicals made by nerve cells to carry specific messages to target cells. Several neurotransmitters were identified as responsible for our emotional responses to stimuli and overall wellbeing. So let's talk about each of these chemicals in turn.

DOPAMINE: Pleasure and satisfaction
TOO MUCH: anxiety, mania & stress
TOO LITTLE: depression & low motivation

SEROTONIN: Mood – happiness
TOO MUCH: confusion, agitation & restlessness
TOO LITTLE: depression, anxiety & sleeping problems

ADRENALINE: Fight or flight
TOO MUCH: anxiety, stress & restlessness
TOO LITTLE: limited response to stress

GABA: Tranquility
TOO MUCH: unsteady balance, slurred speech & unclear thinking
TOO LITTLE: poor impulse control, mania & insomnia



All of us have these four chemicals periodically flowing through our brain in response to our environment. But the reality is each of us develop very different brain chemistry, affecting how these four chemicals manifest in each of us. So it's important to remember how each of us is wired is different based on our early life experiences, varying the effect and frequency of release of each of these happy chemicals in our brain.

9

Chemistry Of Nebulae

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A Nebula is an enormous cloud of dust and gas occupying the space between stars and acting as a nursery for new stars. The complex structures of dust intertwined with the plasma of superheated gases make up for one of the most gorgeous sights in the sky.

Where does this beauty come from?

Helix nebula located in Aquarius about 700 light years away from earth.

It derives from astrophysical processes driven by the law of physics and chemistry. Gravity acts on a particle of gas in a nebula causing them to clump together. In such gas-rich regions of our galaxy some intriguing chemistry take place and it give rise to nebulae. The chemistry of nebulae is a bit different from chemistry in which we encounter every day in earth due to the presence of highly energetic chemical reactions. The molecules can be formed in a gas phase or onto the solid surface.

Helix nebula located in Aquarius about 700 light years away from earth.

Due to high surface temperatures that are greater than 10,000K, the chemicals are easily ionized, recombining with other newly formed species.

Most nebulae are full of stars, which are the sources of light elements like hydrogen, helium, neon, argon, and some other ionized gases. Depending upon the types of nebulae the cloud contains a lot of carbon, nitrogen, oxygen, chlorine, sulfur, and even higher elements like silicon, magnesium, and iron in solid and ionized forms as well as chemical compounds like carbon monoxide are also seen.

TYPES OF NEBULAE:

EMISSION NEBULAE: This type of nebulae is full of stars surrounded by very hot clouds of ionized gases which emit their light. The glowing shell of gas ejects from the red giant stars late in their lives has a chemical composition as simple compared to the other nebulae.

ELEMENTS: The dominant element present in these nebulae is the ionized hydrogen gives their characteristic red color. Other elements such as Helium, O, N, and trace elements give the green color.

REFLECTION NEBULAE: It is similar to emission nebulae and has star-like composition. They are relatively cold, from its name it suggests that it reflects light from nearby stars, without those stars it would be darker and usually surrounded by young and hot stars.

ELEMENTS:

Reflection nebulae are full of hydrogen, neon and also it confirms the presence of polycyclic aromatic hydrocarbons in which aromatic rings are bonded with hundreds of carbon atoms, and some hydrogen atoms were arranged in a honey-comb like structures. Those can be transformed into other species like fullerenes.

PLANETARY NEBULAE:

In this type, the spectra records indicate the highest optical signal for hydrogen, carbon, oxygen, and neon ions. However, nebulae are formed by stars that are in later stages of evolution become sources of many different molecules especially it contains long carbon chains, and it also possesses a more complex composition compared to reflection and emission nebulae.

ELEMENTS:

Detection of carbon-based molecules like C_4H_2, C_6H_2, C_2H_4 or even aromatic benzene, benzonitrile, and oxygen-bearing molecules like H2O, OH, or HCO+ and Sulphur-based compounds like CS, C_2S, C_3S, OCS in this type of nebulae. They surround the hot heart of nebula- the dying star. Their light emission gives a wide variety of colors.

DARK NEBULAE:

In comparison to planetary nebulae it is denser clouds of gas and dust. They are full of much heavier metals and also full of hundreds of chemicals like H_2, H_2O, CO, CO_2, CH_3, OH, NH_3, Ethyl alcohol, sugars even amino acids like glycine that are fundamental building blocks of life, even 70 of them along with these which build the DNA, widely detected in meteorites. The dark nebulae are full of solids like C, Si, Mg, Fe, Al, Ti, Ca, or even magnesium iron silicates $(Mg, Fe)_2SiO_4$.

What about the hottest that is energetic nebulae (supernova remnants)?

Due to the violent supernova explosion, it happens when a massive and it dies in an explosion-like event. The reactions take place there to create chemicals that undergo extreme conditions and form strongly ionized clouds. Studies reveal that the presence of many different species from ArH^+ created molecular hydrogens and argon ions to the SiO, SiS, CO, and HCO^+ in such nebulae. This type of nebulae despite being the last stage of the star's life is a new beginning of the new species in the universe.

To conclude the nebulae which present in some extreme conditions in the universe where various highly ionized gases mix while also being exposed to strong electromagnetic radiation.

References

Joint work of Karol Masztalerz (the University of Manchester, Faculty of Science and Engineering),AgnieszkaPregowska (Institute of Fundamental Technological Research, Polish Academy of Sciences), Magdalena Osial (Faculty of Chemistry, University of Warsaw) as a part of Science Embassy project.

10

The Chemistry Of Sunscreen

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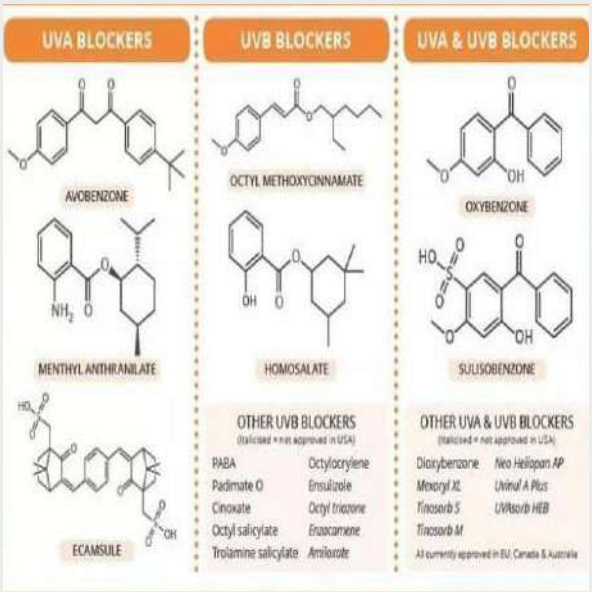
Summer suns brings with it the risk of sunburns so we will be slapping on the sunscreen to guard against it. But what are the chemicals that keep you from turning as red as lobster? We can check.

TYPES OF UV RADIATIONS

1.UVA 320-400nm (wave length): Accounts for 95% of solar UV radiation reaching Earth's surface. Penetrates deepest into the skin and contributes to skin cancer via indirect DNA damage.

2.UVB 290-320nm: Accounts for 5% of solar UV radiation reaching Earth's surface. Causes direct DNA damage, and is one of the main contributors to skin cancer.

3.UVC 290-100nm : Filtered out by ozone in earth's atmosphere, and as a result does not reach the surface of the earth and doesn't cause skin damage.



Inorganic chemicals in sunscreen such as zinc oxide and titanium oxide both absorb and scatter UV light. Organic chemicals are also used the chemical bonds in these absorb UV radiations with the chemical structure affecting whether they absorb UVA, UVB or both. Several different chemicals are used in sunscreen to ensure full protection.

11

The Chemistry Behind Bioluminescence In Fireflies

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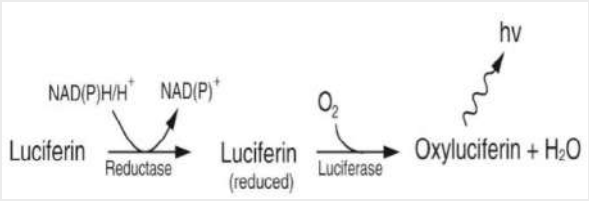
Light has always fascinated human beings, when this is from natural sources it excites us more. Bioluminescence is a fascinating method by which living organisms convert chemical energy into light. This is shown by many organisms like insects, bacteria, fungi, crustaceans, and fishes. The light results from the oxidation of an organic substrate, luciferin, catalysed by an enzyme called a luciferase.

The basic biochemistry of bioluminescence includes an enzyme-mediated reaction between molecular oxygen and an organic substrate, and the formation and breakdown of a four-member ring peroxide or a linear hydroperoxide.

BIOCHEMICAL REACTION OF BIOLUMINISCENCE

Bioluminescent reactions vary greatly among organisms but can generally be described as a luciferase catalysed production of an excited intermediate from oxygen and luciferin that emits light when returning to its ground state. Many bioluminescence systems may involve cofactors like $FMNH_2$, ATP, other enzymes and intermediate steps for emitting light, while in some systems special types luciferases, *photoproteins*, bind and stabilize the oxygenated luciferin and emit light only in the presence of cations, such as Mg^{2+} or Ca^{2+}, which acts as a mechanism for the host to precisely control the timing of the light emission.



A detailled explaination to this is:

Firefly luciferase (Luc) has a specificity for adenosine triphosphate (ATP) so it binds instantly and converts firefly D-luciferin (LH_2) into the corresponding enzyme-bound luciferyl adenylate (Luc.LH2 - AMP).

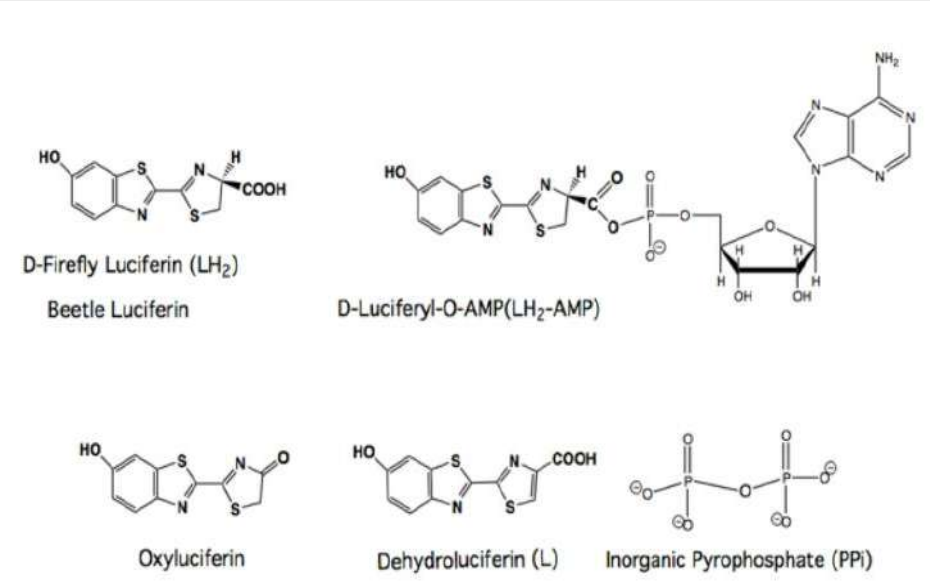
$$\text{Luc} + \text{D-LH}_2 + \text{ATP} \overset{Mg^{2+}}{\leftrightarrows} \text{Luc·LH}_2\text{-AMP} + PP_i$$

The enzyme bound complex reacts with oxygen in the presence of luciferase to produce light emission similar to the one obtained with the natural substrates D-luciferin and Mg-ATP.

$$\text{Luc·LH}_2\text{-AMP} + O_2 \rightarrow \text{Luc·Oxyluciferin}^* + \text{AMP} + CO_2$$

$$\text{Luc·Oxyluciferin}^* \rightarrow \text{Luc·Oxyluciferin} + \text{light}$$

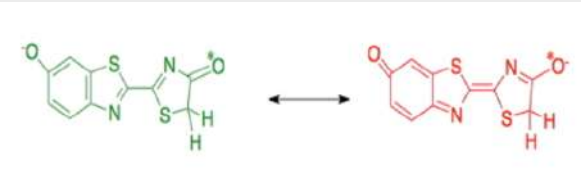
$$\text{Luc} + \text{L} + \text{ATP} \overset{Mg^{2+}}{\rightarrow} \text{Luc·L-AMP} + PP_i$$



The luciferase functions as a mono-oxygenase enzyme, without the apparent involvement of a metal or cofactor. Luciferase amino acid residues are used to promote the addition of molecular oxygen to the D-luciferin adenylate complex, which produce an electronically excited state oxyluciferin molecule and carbondioxide, from a highly reactive dioxetanone intermediate. The excited state oxyluciferin molecule emit radiation in the visible region via a fluorescence pathway by loss of energy and comes to ground state. The very high quantum yield of this process is because of its efficient catalytic machinery, as well as the favourable environment that prevents electronically excited state energy loss by non-light emitting pathways.

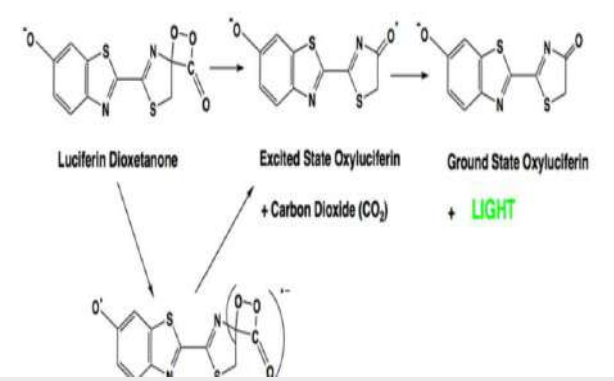
The oxyluciferin emitter is of two type, keto form and enolate dianion form. According to the original mechanism based on chemiluminescence model studies, red light emission (λmax 615 nm), which is observed at pH 6.0, results from the keto form of the emitter. And the enolate dianion emits yellow-green light (λmax 560 nm) at Ph 8 by persuaded enzymatic assisted tautomerization.

In nature, beetle luciferases display various colours of light from green to red. Luciferase modulates emission colour by altering the resonance-based charge delocalization of the excited state.



The high energy (40-70 kcal/mol) needed to emit visible light is gained from the dioxetanone intermediate contains a strained four-member ring as well as a weak peroxide bond (O-O). The cleavage of the high energy dioxetanone ring releases the required high energy as a result of the low energy of activation to cleave the peroxide bond, and the relief of the ring strain inherent in the structure.

In the firefly, the energy released is very efficiently directed into the production of an electronically excited state of the bioluminescence product oxyluciferin. Subsequent rapid relaxation of the excited state to the ground state is then accompanied by the emission of a photon of light.



The detailed mechanistic view of this process is termed the CIEEL (Chemically Initiated Electron Exchange Luminescence) mechanism.

References

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Chemistry of firefly bioluminescence, Bruce R. Branchini, Department of Chemistry, Connecticut College, New London,

2.https://www.cell.com/current-biology/comments/S0960-9822(16)00046-4

Current biology, bioluminescence

12

Chemistry Crossword

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Questions

Across:

5. The oxygen atom in furan is replaced by sulfur, then the name of the compoundis ___.

6. A six membered aromatic ring ($C_4H_4N_2$) with two nitrogen positioned ortho to one another is called ____.

8. A five membered aromatic ring ($C_3H_4N_2$) with two nitrogen positioned Meta to one another is called ___.

10. A five membered aromatic ring (C_3H_3NO) with nitrogen and oxygen positioned Meta to one another is called __.

11. A five membered aromatic ring ($C_2H_3N_3$) is called ____.

12. A five membered aromatic ring ($C_3H_4N_2$) with two nitrogen positioned ortho to one another is called ___.

Down:

1. A five membered aromatic ring with chemical formula CH_2N_4 is called ___.

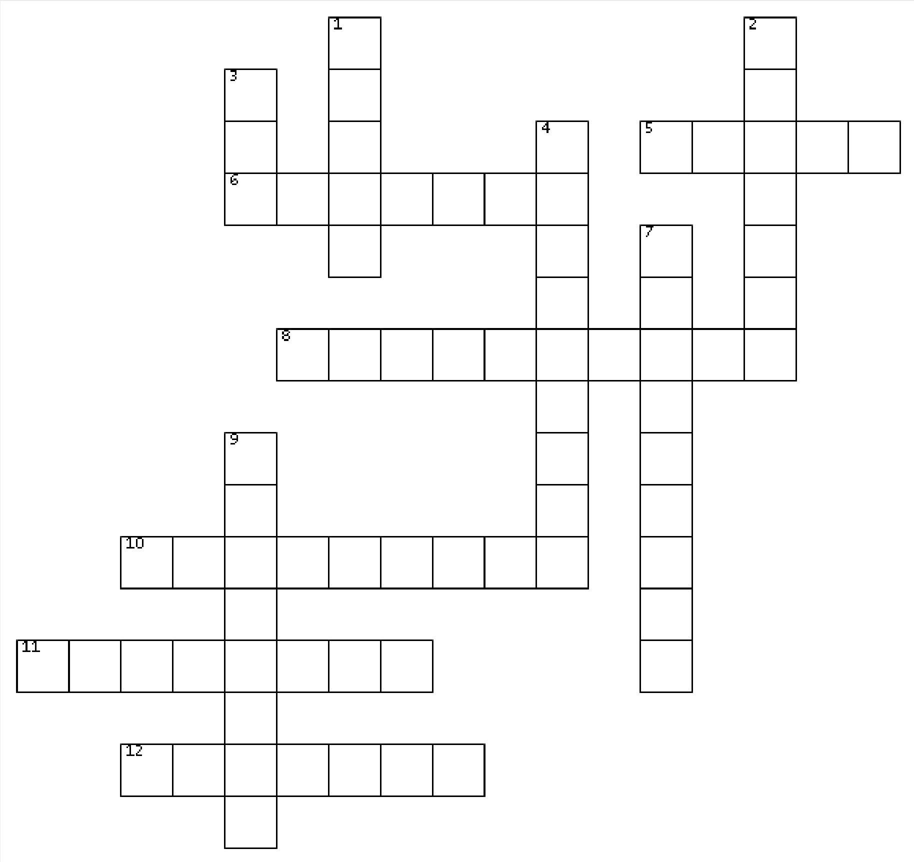
2. In pyridine, the favored position for electrophilic substitution reaction is (position no) is ____.

3. Quinoline is used to treat ____.

4. Pyrrole is prepared industrially by treatment of ___ with ammonia in the presence of solid acid catalysts like SiO_2 and Al_2O_3.

Answers

7. When hexane- 2, 5 Dione is mixed with ammonia the product formed is _.



Answers

1. Tetrazole
3. Malaria
5. Thiophene
7. Pyrrole
8. Imidazole
9. Two

2. Three
4. Furan
6. Pyridazine
10. Oxazole
11. Triazole
12. Pyrazole

13

Quiz Time

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1.

ICC banned the cricket bat "Kookaburra Kahuna" in 2007. This created controversy as many high-profile players like Ricky Ponting and Michael Hussey was using the same. ICC banned it like the back of the entire bat was coated with a thin layer of particular material which strengthens the blade and helps in shock absorption. What was the material used at its backside?

2. Guess these personalities.

3.

The phenomenon that explains the following reasons is?
~The main reason is the formation of an even layer of crystalline iron hydrogen phosphate on its surface.
~Almost 70% of relative humidity in that location for a significant period in the year is also responsible for this phenomenon.
~The material used is made up of a relatively pure composition of iron with the presence of Phosphorous and also neither Sulphur nor Magnesium was used.

4

This Google Doodle was posted to commemorate the 100th birthday anniversary of an Indian Organic Woman Chemist. Do you know who was that?

5.

In 1962, a certain chemical dye was used to trace sources of illegal pollution discharge by Plumbers in Chicago. They found that the dye eventually flowed into the Chicago River. The view was impressive enough to make the plumbers Union do this every year, in observance of St. Patrick's day. Later for safety measures, they switched to a vegetable dye in 1966.What was that Chemical dye?

6. Identify 'X'

✓ 'X' also known as connectin, is a protein important in striated muscle tissues contraction. This connects the Z line to the M line in the sarcomere.

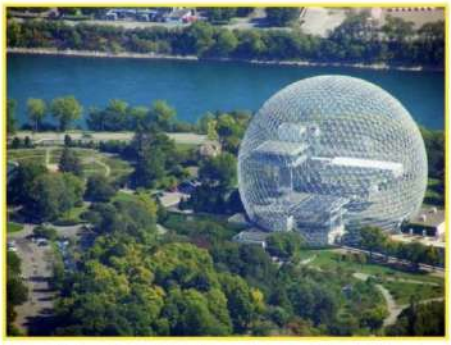
✓ 'X' also known as connectin, is a protein important in the contraction of striated muscle tissues It connects the Z line to the M line in the sarcomere.

✓ After myosin and actin, 'X' is the third most abundant protein in muscle and an adult human contains approximately 0.5 kg of 'X' With its length of 27,000 to 33,000 amino acids (depending on the splice isoform), 'X' is the largest known protein.

✓ As the largest known protein, 'X' also has the longest IUPAC name. The full chemical name contains 189,819 letters 🤯 and is sometimes stated to be the longest word in the English language or any language.

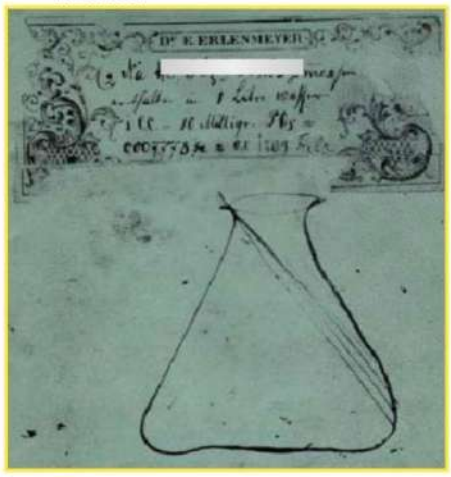
7. The following image is a statue over the grave of famous identify the scientist.

8.



The Montreal Biosphere is a museum dedicated to the environment in Montreal, Quebec, Canada. It is housed in the former United States pavilion constructed for' Expo 67' located within the grounds of Parc Jean-Drapeau on Saint Helen's Island. Which architect designed the museum's geodesic dome?

9. Identify the blanked-out name?

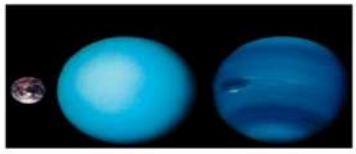


10.

In 2011-12, The Royal Society of Chemistry website published a series of articles with such titles as "Poisoning...With Phosphine Gas", "Acid Bath Disposal of Bodies", "Can a Little Crystal Blow Up a Room" and "Thermite Break-in".

What were these articles trying to investigate!

11. Connect 👀



Find the specific theme connecting these 6 images.

12.

Ig Nobel prize-winning Soviet crystallographer Yuri Struchkov published a staggering 948 chemical research papers in ten years from 1981-1990 (about one every four days).
But he received Ig Nobel prize, not for chemistry. What is it in?

13. Identify the Logo.

14.

The Swedish village where this sign stands is immensely important to chemistry. What is the village called?

15.

In 1848, this 26 year old from France was working on a problem concerning with two acids commonly found in the sediments of fermenting wine. The only problem was that these two acids were chemically completely identicall
He finally solved the problem when he studied the crystals of each acid under his microscope and noticed they were slightly different. In the process,he had pioneered a whole new field of chemistry.

What would be the case with those two acids? Who would the young man be?

ANSWERS

1. **Carbon fiber**

2. **Benjamin List, David WC MacMillan**

The 2021 Nobel Prize in Chemistry was awarded to German scientist Benjamin List of the Max Planck Institute and Scotland-born scientist David W.C. MacMillan of Princeton University "for the development of asymmetric organocatalysis".

3. **The corrosion resistance of Delhi iron pillar**

The iron pillar of Delhi was constructed by Chandragupta II , It is famous for the rust-resistant composition of the metals used in its construction.

4. **Dr Asima Chatterjee**

Asima Chatterjee was the first woman to be awarded a Doctor of Science by an Indian University - in 1944, by the University of Calcutta. She was also the first woman to be elected as - the General President of the Indian Science Congress.

6. **Titin**

It takes about three-and-a-half hours to pronounce full chemical name

7. **Ludwig Boltzmann**

8. **Buckminster Fuller**

The architect Buckminster Fuller popularized geodesic domes in the late 1940s. The domes are structures that sustain their own weight and, despite their curved appearance, consist of planar equilateral triangles.

When chemists discovered the spherical C 60 molecule in 1985, it was natural to name it buckminsterfullerene or, colloquially, "buckyballs". Although Fuller's domes consist only of triangles, C60 contains regular pentagons and hexagons.

9. **Emil Erlenmeyer**

He was a German chemist known for contributing to the early development of the theory of structure, formulating the Erlenmeyer rule, and designing the Erlenmeyer flask (our conical flask🤠)

11. **Elements in the Actinide Series**

Thorium
Uranium, Neptunium, Plutonium
Americium (Christopher Columbus)
Curium
Einsteinium
Nobelium

12. **Literature**

The Ig Nobel Prize is a satirical prize created in 1991 by Marc Abrahams, editor and co-founder of the Annals of Improbable Research, awarded for scientific achievements that make people laugh and then make them think.

13. **IUPAC : international Union for Pure And Applied Chemistry**

14. **Ytterby**

It is a small town in Sweden that four elements named after it. Those elements are: yttrium(Y), terbium (Tb) , erbium (Er), ytterbium (Yb)

In addition, three other lanthanides, holmium, thulium , and gadolinium can trace their discovery to the same quarry making it the location with most elements named after it.

15. **The man would be Louis Pasteur. The 2 acids are tartaric acid and para-tartaric acid. This was the first time chiral molecules was observed.**

14

Chemistry crossword

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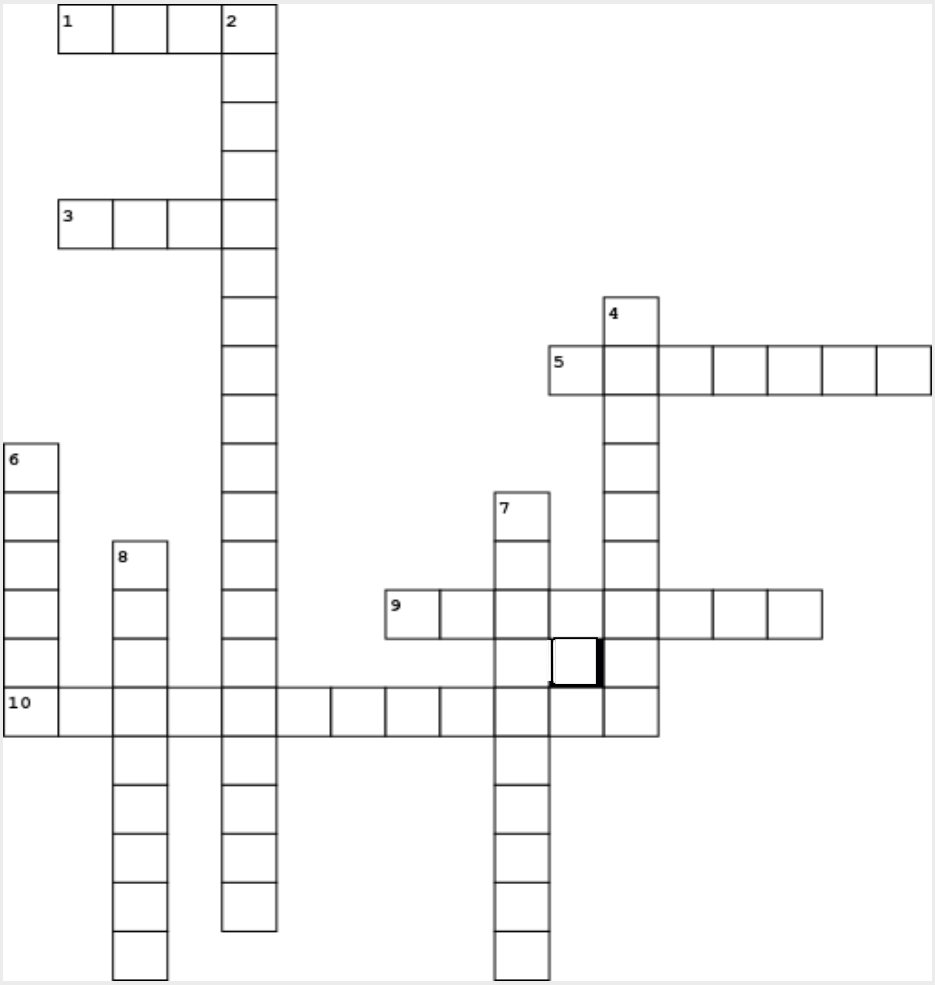

Across

1. a seaweed rich in iodine salt...(4)
3. first organic compound synthesised in laboratory(4)
5. natural disaster - CO2 erupting from deep lake water(7)
9. catalytic convertors are made of....(8)
10. oxide used in anaesthetic(12)

Down

2. oxidising agent present in breathalyser used for checking drunken drive(19)
4. philosopher's wool(9)
6. ink is made from ....(6)
7. rust in clothes can be removed using (10)
8. compound used to accelerate the ripening process of fruits(9)

Answers

Across : 1. Kelp 3. Urea 5.Limnic 9. Platinum 10. Nitrous oxide

Down: 2. Potassium oxide 4. Zinc oxide 6. Tannin 7. Oxalic acid 8. Acetylene

15

Crossword puzzle : Laboratory Equipments

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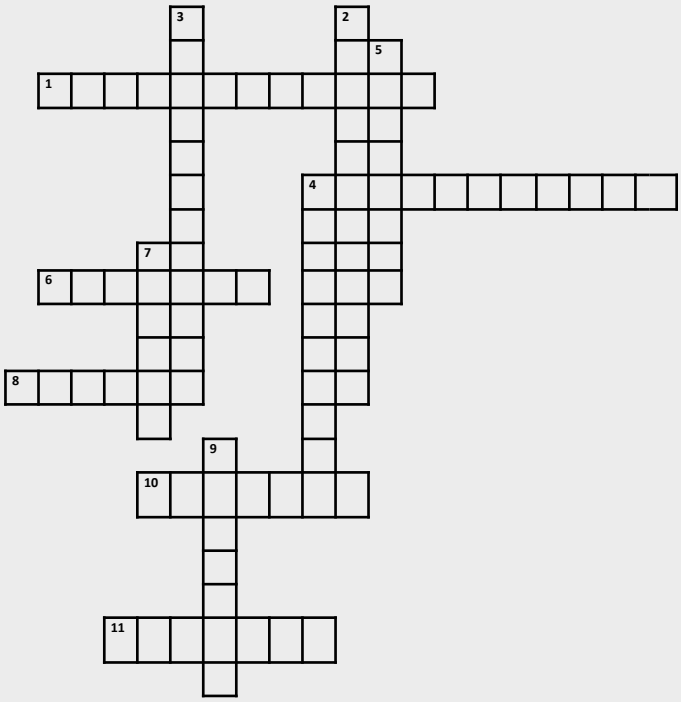
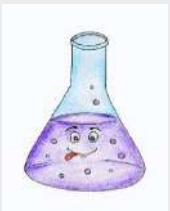


Fill the box with Laboratory Apparatus

Top to Bottom

3.

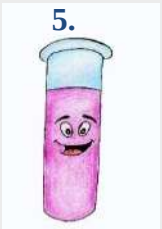
2.



4.

9.

5.



7.

Across

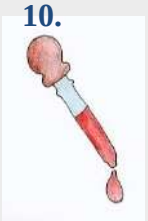
1.

4.

4.

8.

10.



11.

16

Find Me Who Am I ?

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Try answering the following questions. The first letter of the answer to odd number questions and second letter of the answer to even number questions are to be filled in respective numbered box. You will get my name.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

1. The compound containing this element in onion makes you cry while slicing it. The element is __.
2. This made our representation of the 3D molecule easier.
3. This law tells us the partial vapor pressure of each component in an ideal mixture of liquids.
4. This tool is particularly used in the sugar industry to measure the sugar concentration of syrup.
5. This phenomenon tells us the reason behind the blue color of the sky.
6. The idea that everything is made of atoms was pioneered by __.
7. This precursor of iron nano-particles can be used in the production of nanotubes.
8. This core-shell structure of nanometer-sized semiconductor particles is referred to as __.
9. Bromoacetone, thionyl chloride, 2-chlorobenzalmalonitrile – All these share a common property.
10. In this technique of studying fast reactions, the sample is first excited by the pulse of light of nanosecond to femtosecond pulse.
11. The abnormal building up of beta-amyloid protein in the brain cell causes this disease in humans.
12. The rearrangement reaction in which carbonyl derivative reacts with an azide resulting in an amine or amide compound.
13. This nitrogenous compound which is secreted by mast cells involves in the immune response.
14. Silicon dioxide is often found in nature as __.
15. This Constituent Board of Quality Council of India grants accreditation to testing laboratories(Abbreviation).
16. This metal chelating agent is extensively used for the treatment of patients who have been poisoned with heavy metals. (Abbreviation).
17. The vapors emitted from the heated fluids are cooled by this apparatus in the circulation cooling method.

18. This process is used for refining bauxite to produce alumina.

19. Hydrogenation of alkenes can be done with this catalyst. This catalyst is an alloy and highly pyrophoric.

20. Any metal that is found pure in its metallic from in nature is know as __ .

21. The neutral dipolar molecule used in the Wittig reaction is phosphonium __.

Answer

S	I	R

P	R	A	F	U	L	L	A

C	H	A	N	D	R	A

R	A	Y

1. Sulphur
2. Fischer projection
3. Raoult's Law
4. Optical Activity
5. Rayleigh Scattering
6. Dalton
7. Ferrocene
8. Quantum Dots
9. Lachrymator
10. Flash Photolysis
11. Alzheimer's disease
12. Schmidth
13. Histamine
14. Sand
15. NABL
16. EDTA
17. Reflux condenser
18. Bayer's process
19. Raney-Nickel
20. Native metal
21. Ylide

17

Brain Game

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Across

3. Name the reagent (K_2HgI_4)

6. Reaction involving thioketal intermediate

7. The most common ore of Arsenic.

10. The substrate which cause bioluminescence.

11. Preparation of primary aliphatic amines by acidic hydrolysis of quaternary amines formed from alkyl halides and urotropine is known as ____ reaction

12. Unit of conductance (G)?

Down

1. Which chemical is used to detect blood strain at a crime scene?

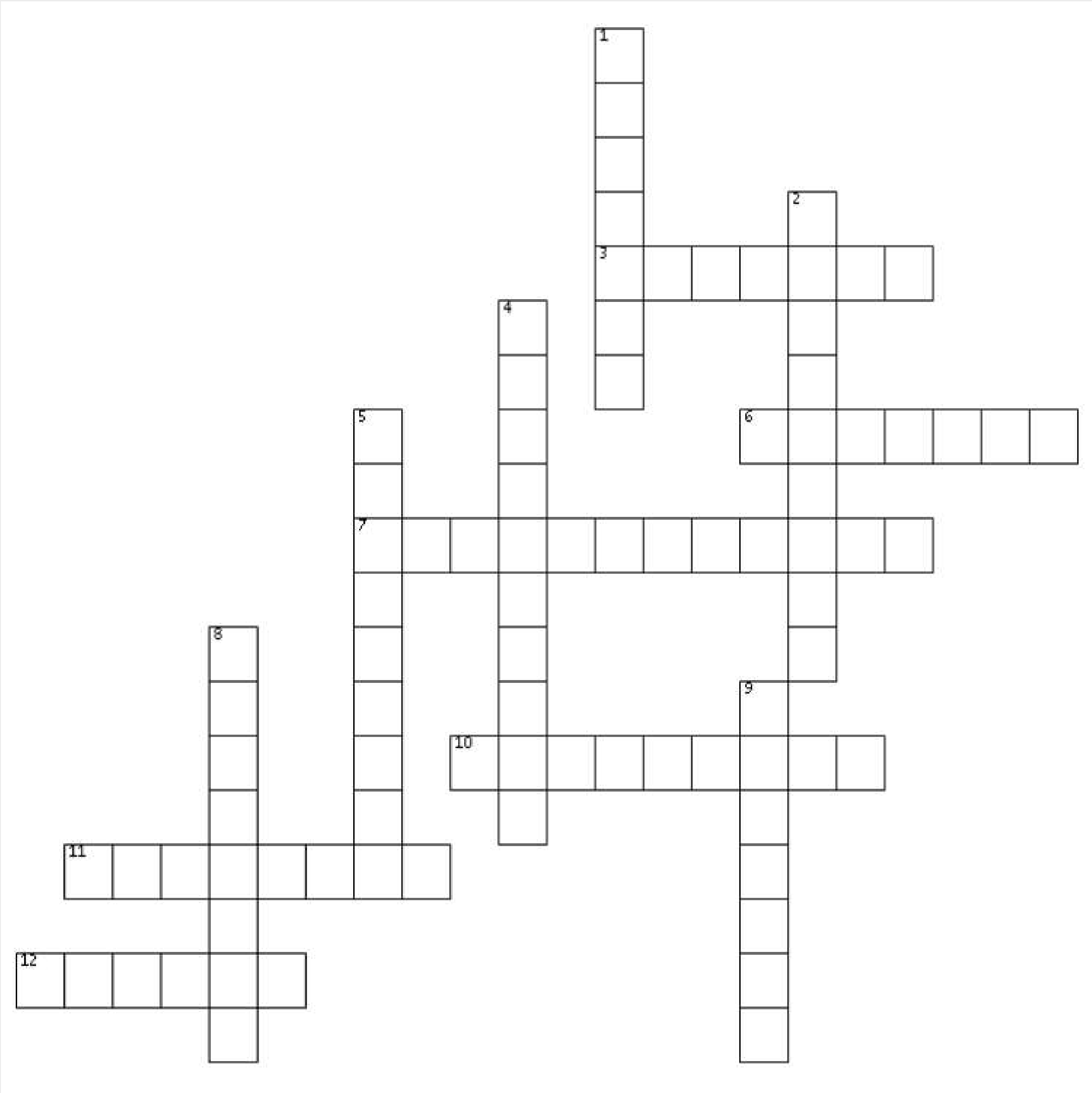
2. The element which has the highest oxidation state in actinide series.

4. Lanthanoid element which is obtained by synthetic method?

5. Who is the father of photochemistry?

8. Which class of chemicals are responsible for the pleasant odour of roses?

9. Name the Radioactive Isotope of Hydrogen.



Answers

Across

3. Nessler 6. Mozingo 7. Arsenopyrite

10. Luceferin 11. Delepine 12. Siemen

Down

1. Luminol 2. Plutonium 4. Promethium

5. Ciamician 8. Terpene 9. Tritium

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