CHEMAZINE

By Department of Chemistry

CITY COLLEGE

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Acknowledgement

We are extremely fortunate to have a lot of encouragement, support, guidance and assistance from our classmates as well as the Professors of our Department led by our Head of the Department Dr. Sharmila Basu Sarkar for the success and final outcome of this magazine.

We express our sincere gratitude to all of them.

It has been a worthwhile project indeed for a good lesson to help our future academic endeavours.

We would love to see our very own CHEMAZINE exist in the following days in physical or e-form, reflecting young minds tuned to the science and arts of chemistry.

MESSAGE FROM THE HEAD OF THE DEPARTMENT

DR. SARMILA BASU (SARKAR)

H.O.D

DEPARTMENT OF CHEMISTRY

CITY COLLEGE, KOLKATA

I was quite amazed when the draft copy of our departmental magazine (**Chemazine-23**) was brought to me by our enthusiastic students: it was so assiduously prepared, with much thought-of contents----- in a word it was commendable.

The magazine embraces some curious as well as serious topics varying from Pujoie naki Chemistry" to Bioluminescence, toxicity packaged water to genotoxicity etc.; some has kindled hope to lighten darkness using greener ways, at the same time, social conduit between the past and the present has eagerly been flashed by way of an interview, which has given a new dimension to the magazine.

I must thank my departmental colleagues, who have evoked the brilliant minds of our students, and our principal for his constant support.

পুজোয় নাকি কেমিস্ট্রি?

আজ মহালয়া। আর মাত্র পাঁচ দিনের মাথায় পুজো। অবশ্য পুজোর আমেজ এইবার খানিকটা হলেও ফিকে হয়েছে,

কারণ স্কুল খুললেই রুকুর একটা প্রোজেক্ট জমা দিতে হবে। তার কয়েকদিন বাদেই টেস্ট পরীক্ষা। রুকু মানে

আমাদের উমানাথ বাবুর ছেলে। কী? মনে পড়ছে না? আরে রুকু! সেই "জয় বাবা ফেলুনাথ" গল্পের বাচ্চা ছেলে

রুকুর বয়স এখন সতেরো, এই বছরেই উচ্চ মাধ্যমিক দেবে। বাবার ইচ্ছেয়ে রুকু বিজ্ঞান নিয়ে পড়ছে। এমনটা

নয় যে ওর পড়তে ভালো লাগে না। কিন্তু তাই বলে পুজো মাটি করে?! তাদের রসায়নের মাস্টার মশাই আবার বাকি

মাস্টার মশাই দের থেকে একটু বেশিই কড়া, একদিন দেরি হলেও উনি পরীক্ষায় নম্বর কেটে নেবেন। বাড়ির

লোকেরাও এইবার তাই রুকুর পুজোয় জোগ দেওয়ায় বাঁধ সেঁধেছে। এর মধ্যে কি আর পড়াশোনা হয়? তাও নাকি

আবার তাকে ভেবে চিন্তে প্রোজেক্ট এর বিষয় খুঁজে বের করতে হবে। ধুর! ভালো লাগে না। দরজার সামনে

দাঁড়িয়ে থাকা রুকুর দাদু, অম্বিকা বাবু সবটা লক্ষ্য করলেন। নাতীর দুঃখ দেখে তিনিও বেশ দুঃখ পেলেন। রুকুর

কাছে গিয়ে তিনি বললেন "শশীবাবুর তো মুর্তি প্রায় তৈরী হয়ে গেলো। আজ চক্ষুদান করবেন। যা গিয়ে একবারটি

দেখে আয়। দেখবি, মন ভালো হয়ে যাবে। কেউ বকতে এলে বলবি দাদু বলেছে। যা।“ রুকু একগাল হেসে দৌড়ে সিঁড়ি

বেয়ে নেমে এলো ঠাকুর দালানের কাছটায়। এসে বসলো মুর্তির সামনে। মুর্তির কাজ তখনও সবে অর্ধেকটা শেষ

হয়েছে। সাদা, কালো, লাল, বিভিন্ন সব রঙের কৌটো, তুলি ছড়িয়ে ছিটিয়ে পড়ে রয়েছে। শশী বাবু তখন চা

খাচ্ছিলেন। রুকু এসে বসতেই তাকে জিজ্ঞেস করলেন, “কী রুকু বাবু, পড়াশোনা কেমন চলছে?” রুকু বললও, “ও

নাম মুখেও এনোনা! একটু যে পুজোয় আনন্দ করবো, তারও জো নেই! তোমার কী? তুমি তো দিব্যি মুর্তি তৈরী

করছো। তোমাকে তো আর রসায়নের প্রজেক্ট নিয়ে মাথা ঘামাতে হচ্ছে না!” শশী বাবু বললেন “ওমা! আমিও তো

প্রজেক্ট তৈরী করছি। ষষ্ঠীর আগে ঠিক মতো প্রজেক্ট জমা না করতে পারলে তো আমার চাকরি যাবে। আর

এতে কতোটা রসায়ন লুকিয়ে আছে, তা কি তুমি জানো?” রুকু জিজ্ঞাসু দৃষ্টিতে শশী বাবুর দিকে তাকিয়ে প্রশ্ন

করলো, “কীরকম?”

শশী বাবু বলা শুরু করলেন, “তবে বলি শোনো। এইযে তুমি এতো বড় মুর্তিটা দেখছো, এতে অজস্র রকমের

রসায়নিক মুন্সিয়ানা লুকিয়ে আছে। মূর্তি তৈরির জন্য ব্যবহৃত মূল উপাদান হল মাটি, এবং এর জন্য সঠিক

মাটির নির্বাচন খুব গুরুত্বপূর্ণ।” রুকু বললও “জানি তো! স্কুলে বলেছে মাটি হচ্ছে সম্পোষিত আলুমিনিয়াম

সিলিকেট। বহু বছর ধরে পাথর ক্ষয় হওয়ার ফলে তৈরি হয়। আবার বিভিন্ন যায়গায় থাকা মাটির গুণাগুণ, ভিন্ন

রকমের।”

শশী বাবু বললেন “তবে? আর এই মাটি যে সে মাটি নয়। গঙ্গা নদীর তীরে যেই মাটি পাওয়া যায়, সেই মাটি হয়

মিহি প্রকৃতির। কেবল সেই মাটি দিয়েই প্রতিমা তৈরি করা সম্ভব। নচেত মাটির বাঁধন খসে পড়বে। তার মধ্যে

আবার সঠিক পরিমানে জলের ব্যবহার খুব দরকারী! জল বেশী হয়ে গেলে মাটি কাঁদার মতো হয়ে যাবে, আবার

কম হলে সেই মাটি দিয়ে মনের মতো আকৃতি দেওয়া অসম্ভব। শুকোতে গেলে তাতে ফাটল ধরবে।”

রুকু মুগ্ধ হয়ে শুনতে থাকে। তাদের বইতে ‘প্লাস্টিসিটির’ কনসেপ্ট তাদের পড়ানো হয়েছে ‘পি-ব্লক’ চ্যাপ্টারে।

শশী বাবু আবার বলেন, “মাটি মাখতে লাগে, কি বলে বেশ, সংযোজক! সংযোজনের জন্য মূলতঃ গাছের উপাদান

ব্যবহার করা হয়। এই উপাদানগুলি মাটির কণাগুলোকে জুড়ে রাখবার কাজে লাগে। মাটির মিশ্রণে খড় আর পাটের

ফাইবার ব্যবহার করা হয় যা তাঁর কাঠামোয় শক্তি আনে।” রুকু জানে, ভৌতিক বিজ্ঞানের মাস্টার মশাই

একবার টেন্সাইল স্টেন্হ (প্রসার্য শক্তি) পড়ানোর সময় এর উল্লেখ করেছিলেন। শশী বাবু বললেন

“তাহলেই ভাবো একবার! কত কিছু থাকে ওই মিশ্রণের মধ্যে। যদি একটা জিনিষও এদিক ওদিক হয়ে যায়, আর

মুর্তি তৈরী হওয়ার জো নেই।”

রুকু প্রশ্ন করলো, “তারপর?”। শশী বাবু বললেন, “তারপর? তারপর ওই মাটিটা ভালো ভাবে মেখে, তার প্রলেপ

চড়ানো হয় মুর্তির খড় আর বাঁশের তৈরি কাঠামোর উপর। কাঠামোয় মাথা, হাতের মুঠো, পায়ের চরণ, এসব

কিছুই থাকেনা। ওই অংশগুলো পুরোটাই মাটির তৈরী। সব সুদ্ধ তিনটি মাটির প্রলেপ পড়ে। প্রথমটায়ে জলের

পরিমাণ থাকে বেশি, যাতে খড়ের মধ্যে থাকা ফাঁকগুলো ভরাট করা যায়। তারপরের প্রলেপটা সবচাইতে জরুরি।

এর উপরই নির্ভর করে প্রতিমার আকৃতি কিরকম হবে। মুর্তির মাথাটা আবার অন্য ভাবে তৈরি করা হয়,

তারপর সেটা কাঠামোর সঙ্গে জুড়ে দেওয়া হয়। এইযে পুরো জিনিসটা তৈরি হলো, তার উপর চড়ে প্লাস্টার অফ্

প্যারিস। তারপর প্রতিমা ভেজা কাপড়ে মুড়ে, নরম করে, তার উপর করা হয় রঙ। প্রথমে চুন রঙ, তারপর আসল

রঙ। দুগ্গা, লক্ষী, কাত্তিক হয়ে হলুদ রঙের, সরস্বতী সাদা, গনেশ গোলাপী, আবার অসুর সবুজ। কত রকম রঙ

বলো দিকিনি।” ছেলেবেলায় অনেক বার রুকু ভেবেছে, অসুরের অমন রঙ হয়ে কেন? ওর শরীরে কি ক্লোরোফিল

আছে? কিন্তু পাছে গুরুজনরা রাগ করে, তাই কোনোদিন কাউকে জিজ্ঞেস করতে পারেনি। শশী বাবু বলে চলেছেন,

“তারপর মূর্তির উপর প্রলেপ হয় বাইন্ডার এবং বার্ণিশের। এগুলো তো সবই কেমিকাল, নাকি? কত রকমের

রাসায়নিক দ্রব্য এতে থাকে তাতো আমার থেকে ভালো তুমি বলতে পারবে, রুকু বাবু। এইযে মুর্তিটা তৈরি হলো,

এটাকে শুকিয়ে, পুরোটা আগুনে সেঁকে, ফাইনাল টাচআপ দেওয়া হয়। এই যে সেঁকছো, তাতে তার ভেতরে যা জল

থাকে, সেইটা উবে যায়, আর রঙটা দীর্ঘ স্থায়ী করে দেয়। এতে মুর্তি আরও মজবুত হয়ে যায়। তারপর কাপড়

চোপড়, চুল ইত্যাদি আঠা দিয়ে লাগিয়ে, হাতে অস্ত্র ধরিয়ে দিলেই মুর্তি রেডি!”

রুকু মুগ্ধ হয়ে পুরোটা শুনছিল। ওঁর খেয়ালই হয়নি কখন শশী বাবুর গল্প বলা শেষ হয়ে গিয়েছে, আর কখনই বা

সে বিড়ি ধরিয়ে বাইরে, উঠোনের ধারটায় গিয়ে দাঁড়িয়েছেন। রুকুর মন থেকে এখন সেই উদাস ভাবটা উধাও। সে

আনন্দে আত্মহারা। তার আর মাথা খাটিয়ে প্রজেক্টের বিষয় ভাবতে হবেনা। শশী বাবুর সঙ্গে তার

কথোপকথনটাই সে গুছিয়ে লিখে দেবে।

সে দৌড়তে দৌড়তে সিঁড়ি বেয়ে তরতরিয়ে উপরে উঠে গেল, একগাল হাসি নিয়ে। তারপর কি মনে করে একবার

উপরের বারান্দা থেকে নীচের দিকে তাকিয়ে জোরে বলে উঠলো, “থ্যান্‌ক ইউ শশী বাবু!”। শশী বাবু ততক্ষণে বিড়ি

শেষ করে সবে তুলি রঙে চুবিয়েছেন। রুকুর ধন্যবাদ শুনে একবার মুচকি হেসে মাথা নাড়লেন, তারপর তার কাজে

মন দিলেন।

Unveiling the Invisible Threat: The threat of genotoxicity.

In our ever-evolving world, countless substances and environmental factors surround us, many of which may not even be fully comprehended. Among the innumerable mysteries of science lies a concept called “genotoxicity,” a term that may not be on everyone’s lips but plays a crucial role in our understanding of health and well-being.

Genotoxicity is the hidden peril, an intricate and often unseen threat that can alter the very core of our existence – our DNA. It’s a concept that transcends laboratory walls, affecting the food we eat, the air we breathe, and the products we use. In this exploration, we will embark on a journey to demystify the enigma of genotoxicity, shedding light on what it means for our health, its implications on our surroundings, and the measures we can take to safeguard our genetic heritage. So, buckle up as we delve into the world of genotoxicity and its far-reaching consequences.

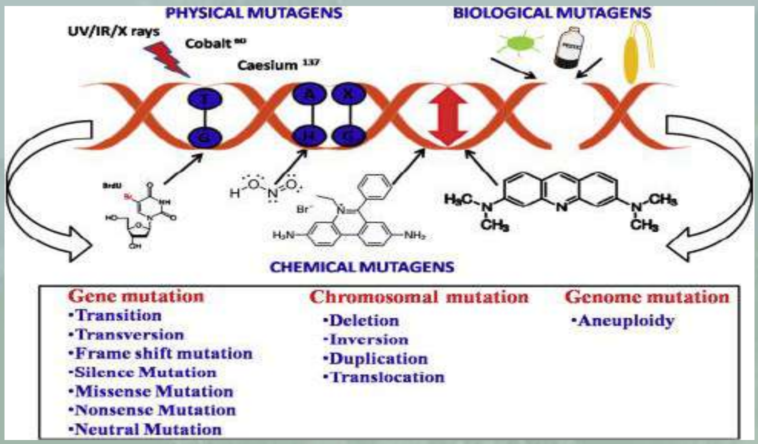
Genotoxic substances are the causative agent for genotoxicity. They are agents that have the potential to damage the genetic integrity within our cells, primarily, by affecting the DNA. These genetic saboteurs can be found in a surprising array of sources, that include all of our surrounding. Their insidious effects can remain hidden for years, manifesting as diseases such as cancer, birth defects, and a variety of genetic disorders.

One prime example of a genotoxic substance is tobacco smoke. Pervading our society for centuries, it contains a cocktail of harmful chemicals that directly interact with our DNA, leading to mutations and, ultimately, the development of several types of cancers. But it doesn't stop there; asbestos fibers, ultraviolet (UV) radiation from the sun, and certain heavy metals like lead and cadmium are all genotoxic culprits lurking in our environment.

For example, the transition metal chromium interacts with DNA in its high-valent oxidation state, incurring DNA lesions which leads to cancer. The metastable oxidation state Cr(V) is achieved through reductive activation. Another example of a genotoxic substance causing DNA damage are pyrrolizidine alkaloids (PAs). These substances are found mainly in plant species and are poisonous to animals, including humans; about half of them have been identified as genotoxic and tumorigenic.

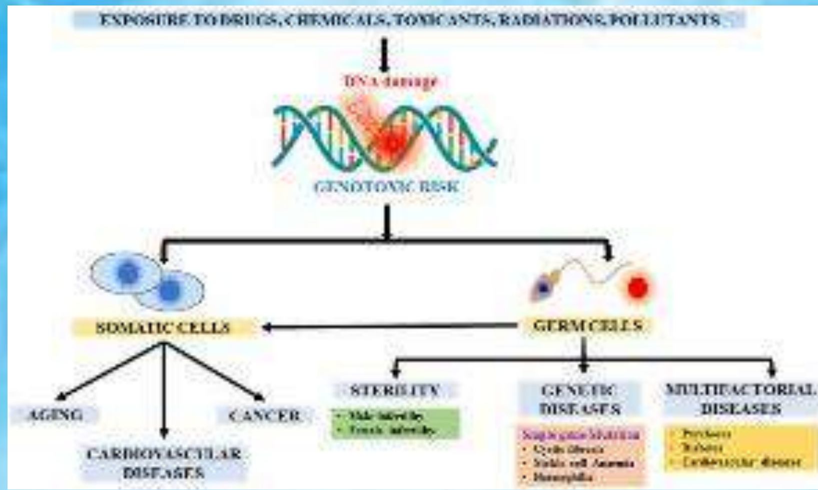
Genotoxic substances are often inconspicuous in our lives. Thus , understanding how does it affect us on a genetic level is pivotal in recognizing their potential harm and taking proactive measures to protect our health.

Major genotoxic agents responsible for the four most common cancers worldwide (lung, breast, colon and stomach) have been identified. While Lung cancer is the most frequent cancer in the world, both in terms of yearly cases and deaths, breast cancer is the second most frequent cancer worldwide on a yearly basis, and ranks 5th as a cause of death.



At their core, genotoxic substances are agents capable of enhancing the risk of mutations(modifying the inherent genetic coding). Here's how genotoxic substances affect us and our DNA:

1. DNA Strand Breaks: Some genotoxic substances, such as ionizing radiation or certain chemicals, directly break the strands of our DNA, leading to errors during DNA repair, resulting in mutations that may initiate the development of cancer or other diseases.
2. Point Mutations: Others cause what are known as point mutations, where a single DNA base is altered. These subtle changes can have profound consequences, potentially giving rise to genetic diseases or predisposing individuals to various health conditions.
3. Chromosomal Aberrations: Genotoxic substances can induce structural changes in our chromosomes, which carry our DNA. These aberrations, such as translocations or deletions, can lead to genetic disorders or cancers, as they often interfere with the proper functioning of genes.
4. Interference with DNA Replication: Some substances disrupt the replication process of DNA, causing mistakes during cell division. These errors can accumulate over time, contributing to the formation of tumors and other health problems.



5. Induction of Reactive Oxygen Species (ROS):Certain genotoxic substances stimulate the production of ROS within cells. Excessive ROS can damage DNA and other cellular components, potentially initiating the onset of cancer and other diseases.
6. Epigenetic Modifications: Genotoxic substances can also trigger epigenetic changes, altering the chemical marks on DNA that control gene expression. These changes can lead to abnormal gene regulation, impacting various biological processes.

The effects of genotoxic substances are not always immediate, and their consequences may take years or even decades to manifest, but have a chronic effect on generations to come, once they get manifested. Furthermore, individuals may vary in their susceptibility to these substances due to genetic factors and lifestyle choices.

Awareness and precaution are key in mitigating the risks posed by genotoxic substances. By recognizing potential sources of exposure, advocating for safer practices and regulations, and making informed choices about our environment and lifestyle, we can minimize the impact of these invisible genetic threats on ourselves and future generations. Our genetic heritage is precious, and understanding the perils of genotoxic substances is a crucial step in preserving it. In a world where genotoxic substances lurk around every corner, taking proactive steps to protect your genetic heritage is paramount.

1. Know Your Environment:- Stay informed about potential sources of genotoxic substances in your surroundings, including workplace hazards, environmental pollutants, and household products. Support environmental policies and initiatives that aim to reduce pollution and limit exposure to genotoxic agents on a broader scale.

2. Quit Smoking and Avoid Tobacco:- Smoking is a major source of genotoxicity. Quitting smoking and avoiding secondhand smoke significantly reduce your risk of DNA damage and cancer.

3. Limit Alcohol Consumption:- Excessive alcohol consumption can contribute to genotoxicity. Moderation is key to safeguarding your genetic material.

4. Avoid Excessive radiation Exposure:- Protect your skin from harmful UV radiation by using sunscreen, wearing protective clothing, and avoiding tanning beds. UV radiation can cause DNA damage leading to skin cancer. Minimize exposure to ionizing radiation from X-rays and other medical procedures unless medically necessary. Follow recommended safety measures when working with radiation sources.

5. Handle Chemicals with Care:- When using household chemicals or working with hazardous substances, follow safety guidelines, wear appropriate protective gear, and ensure proper ventilation to minimize exposure.

6. Maintain a Balanced Diet:-Consume a diet rich in antioxidants, vitamins, and minerals found in fruits, vegetables, and whole grains. These nutrients help repair DNA damage caused by free radicals. Drinking plenty of water helps flush toxins from your body, reducing the concentration of genotoxic substances in your tissues.

7. Screen for Genetic Conditions: - If you have a family history of genetic diseases, consider genetic counseling and testing to understand your risk and take appropriate precautions.

8. Assuring a healthy lifestyle:- Schedule routine medical check-ups and screenings to catch and address health issues early, including cancer and genetic disorders. Chronic stress can weaken your immune system and potentially increase the effects of genotoxicity. Engage in stress-reduction techniques like mindfulness, meditation, or yoga.

9. Promote Workplace Safety: - If your job involves exposure to genotoxic substances, ensure that your workplace adheres to safety regulations, and use protective equipment.

Preventing genotoxicity is a collective effort that involves individual choices, community awareness, and policy changes. By staying informed and taking these preventive measures, you can significantly reduce the risk of DNA damage and ensure a healthier genetic legacy for yourself and future generations. So Consider the next time, you smoke a puff, or drink less water for a prolonged period of time or play with a chemical without knowing, exactly how much hazard, it might pose, as this will not just affect you but all of your lineage down the order, with a weaker, more vulnerable genetic material.

FROM CAMPUS TO CAREER : In CONVERSATION WITH OUR ALUMNI

Dr.S.K.SAMANTA

Renowned Chemist Dr. Suman Kalyan Samanta, who's also fortunately, an alumni of City College, talks about his experiences in an exclusive interview.

Arundhati Chakraborty and Ryan Datta, 29th March 2023

Note: To make it easier, abbreviations were used instead of the full names, i.e., S for Dr.Suman Kalyan Samanta, A for Arundhati Chakraborty and R for Ryan Datta. **A:** Good morning Sir, We find ourselves, extremely lucky to be able to sit in front and speak to you. Shall we go forward with the questions?

S: Sure, Go ahead.

A: What motivated you to pursue Chemistry, as your career?

S: Well, I have always had the guidance of a few well wishers, who were always there for me, to guide me through whatever dilemmas, I have ever faced in my life. I remember, when I was wondering upon what subject I shall be pursuing, I asked Pulin Da about it. At H.S. level, Mathematics used to be my favorite subject, not like I did not take interest in Chemistry, but you know, not the best. He suggested I should be taking Chemistry as a Major. The reason he gave was that pursuing Mathematics will narrow down the options, of careers, I could have pursued, which is certainly not going to be the case with Chemistry. The opportunities would have been far more, in this particular discipline. And this is how I pursued Chemistry.

A: Was City College, alwayss your first choice?

S: Basically, I'm from Midnapore, where I was born and brought up. The main University there, is Vidyasagar University, as you know. Now as I have already mentioned earlier, that mathematics used to be my favorite subject, and naturally, I used to seek a good bit of guidance from the teachers in that particular stream. He was the one who suggested, that if you want to grow, go to Calcutta University. It was the best University in the state at that point (of time). Not like I've been to Calcutta ever before in my life(before pursuing graduation), so I was clueless on what college or colleges I should). So I wa totally clueless about which college or colleges, I should be applying to. I got a chance in Surendranath College, as well as City College, and another mathematics professor, in here, whom I knew personally, suggested to me to join the latter. That's how I opted for City College. And now when I look back (in time), I can say, I wasn't wrong about the call. I learnt a lot more than what I could have expected, which helped me, further in my life.

A: Any good memory, you have had, or been a part of, while in this College? Do you remember someone who's been a guide to you, while you were here?

S: A plentiful of those! I remember BS Sir, and he always used to say "Ei haath gulo je dekhchow, egulo Chemistry'r Haath", These hands, you are looking at, are hands of Chemistry (pointing towards his own hands). Besides, there have been quite a few great Professors, and I was fortunate enough to be studying under them. Another one was Professor MND, who used to teach us Inorganic chemistry. In fact it would be an injustice to name one or two, when we had a bunch of those, who'd all been excellent (professors), with their concepts, their natural understanding of the subject, and the way they used to teach us. The best part which I enjoyed the most about City College, were the lab sessions. It is one of the finest, most well- equipped labs, at this level, I would say, making the experience, wonderful altogether.

R: Do you remember, someone who did actually inspire you to pursue this subject as a career? Maybe a favorite professor of yours, or someone like that?

S: The names, again, as I've mentioned earlier on, that MND sir has been a great influence on me, with the way, he delivered the lectures, made me grow interest in this subject. BS sir, as well! He was so smart, you know, that clearly rejects the stereotype, that Chemistry-Academics or Researchers can't be smart, as in, with the out of the box thinking, you know. They aren't all bores, working with some complex chemicals and performing the experiments which would end up blasting on their face(laughs), as they show in the movies.

R: As we know, chemistry is a subject of experiments. Do you remember a moment or two, while performing one of those, worth mentioning?

Professor Dr. Suman Kalyan Samanta(in centre) along with Arundhati Chakraborty(on his left) and Ryan Datta (on his right).

S: The curriculum for graduate students used to make us identify various organic compounds or several inorganic ions, some of which you all must have already performed yourselves. For those, you need to perform plenty of tests, with different reagents. I remember, using Alizarine once, for some test, and the loads of colorful results you would have obtained, made it all very interesting. While if, for some reason, a test failed, it would just break my heart. These experiments which dealt with

Changing colors will make you wonder, what might have been, possibly the reason for it? Not like every time, it was the same(reason), but those are the wonders of chemistry, isn't it? And this goes parallel with your day-to-day life experiences. Every thing inside you, and around, is composed of atoms, but yet they behave so differently. So I was always keen to drawing parallels between daily occurrences and the ones(experiments) we used to perform in our lab.

R: Sir, has Organic Chemistry always been a subject of interest for you?

S: I developed my bit of interest in Organic(chemistry), from our tuition teacher, Partha pratim Das sir. The way he used to teach, that it made me realize, that this is the subject that'll let you learn everything, from the scratch. The basics, you learnt, in your early classes, will help you solve most of the complex problems you would find later on, throughout your life. Stereochemistry was my favorite, besides a handful of reaction mechanisms, I would still run into, by some way or the other. This made learning effortless and easy, and thereby I pursued Organic(chemistry), later on in my life.

R: And has there ever been a subject, sir, that made you a little nervous?

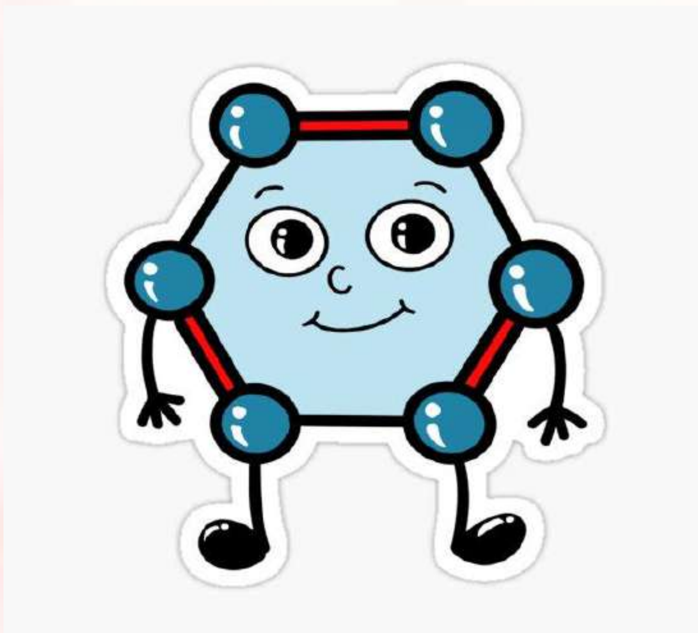
S: Physical chemistry! I will tell you, it is one of the most practical subject, to have ever existed. But you will need a very strong understanding of basic concepts, and there, I lacked it initially, which made me a little repulsive towards the subject. But later on, in my life, when I pursued PHD, I realized, it is hard to differentiate between what is Physical, and what is Organic, you know

You need all of it, for working on a simple stuff. And then when I had to look back, I realized that these equations which were alien language for me, even a few years back, actually makes sense(much more than what I had realized back then). When explaining a reaction, you need to comment and first understand, on the reaction conditions, the entropy factor, the kinetics, the solvent effect, and all of this is what we study in physical chemistry.

R: What's your message to the next "generation" students, who wish to pursue Chemistry?

S: It's all about perspectives. Open your eyes, See it, Feel it, touch it, smell it, it is all around you. You just need to have your interest to seek for the reasons, a quisitive mind and a good teacher, of course! There's no place devoid of chemistry. You can never find it in books, except for the reasons, you look at, but the environment, the nature, that is nothing more than a few chemicals combined.

A & R(together): Thank you so much, sir, for your time.



Illuminating the Future: The Promise of Artificial Photosynthesis

In the heart of our natural world lies a remarkable process that sustains life as we

know it – photosynthesis. This astonishing dance of light, carbon dioxide, and water, performed by green plants, algae, and some bacteria, is the driving force behind Earth's oxygen-rich atmosphere and the foundation of the food web. Yet, as our planet faces unprecedented environmental challenges, scientists are now looking to harness the power of photosynthesis by means of technology, and this is referred to as artificial photosynthesis. First anticipated by the Italian chemist Giacomo Ciamician during 1912, it has developed rapidly over the last century.

But before we embark on this journey into the realm of artificial photosynthesis, let's first unravel the marvel, that is, photosynthesis itself.

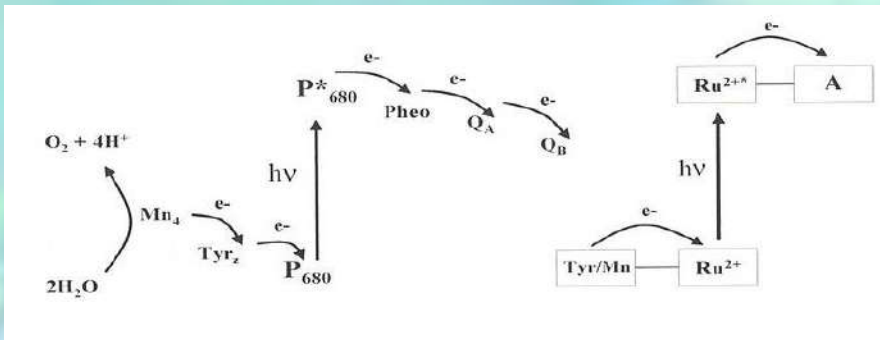
At its core, photosynthesis captures the radiant energy of the sun using chlorophyll, the green pigment found in plant leaves and algae. This energy is then used to split water molecules into oxygen and hydrogen ions, while carbon dioxide is absorbed from the atmosphere. Through a series of intricate chemical reactions, occurring in the chloroplasts, that are tiny cellular organelles that act as nature's solar factories, these elements are transformed into glucose and oxygen, which serve as both sustenance for the organism and a fundamental source of energy for nearly all life on Earth.

The sheer elegance and efficiency of natural photosynthesis have inspired scientists to replicate this process artificially. By doing so, they aim to harness the sun's energy on a grand scale, mitigating climate change, and providing a clean, sustainable source of fuel. In this exploration, we will delve into the fascinating world of artificial photosynthesis, its potential applications, and the exciting possibilities it holds for a greener, more energy-efficient future.

The photosynthetic reaction can be divided into two half-reactions of oxidation and reduction. Primarily the water molecules are photo-oxidized to release oxygen and protons. The second phase, is a light-independent reaction that converts carbon dioxide into glucose. Researchers of artificial photosynthesis are developing photocatalysts that are able to perform both of these reactions simultaneously. Furthermore, the protons resulting from water splitting can be used for hydrogen production. These catalysts must be able to react quickly and efficiently absorb solar radiations.

The purpose of artificial photosynthesis is to produce a sunlight-based fuel, that can be stored conveniently and used even when sunlight is unavailable. With the development of catalysts that are able to reproduce the major parts of photosynthesis, the sole ingredients needed to produce clean energy would ultimately be sunlight, carbon dioxide and water.

Artificial photosynthesis encompasses a range of technologies and approaches. One common strategy involves the use of photo electrochemical cells, where specialized materials capture sunlight and initiate chemical reactions that yield



valuable products. Another approach employs catalysts to facilitate the conversion of water and carbon dioxide into fuels, all driven by solar energy. These technologies are continually evolving, with researchers striving to enhance efficiency and scalability.

Hydrogen is the simplest solar fuel to synthesize. It must, however, be done stepwise, with formation of an intermediate hydride anion:

$$2\,e^{-} + \;2\,H^{+} \rightleftharpoons \;H^{+} + \;H^{-} \rightleftharpoons \;H_2$$

The proton-to-hydrogen converting catalysts present in nature are called hydrogenases. Using this information, several biomimetic materials have been synthesized, that can perform the above mentioned process. Water oxidation, however, is a more complex chemical reaction than proton reduction. An Oxygen evolving complex(OEC) containing Manganese-Calcium cluster, performs the job in nature. Some ruthenium complexes, such as "blue dimer" has been found to mimic the OEC, owing to their higher valence states. Next comes the Carbon fixation phase, that is performed by RuBisCO (Ribulose-1,5-bisphosphate), that turns Carbon dioxide into Glucose, which in turn is a precursor to more complex carbohydrates. Artificial CO2 reduction for fuel production aims mostly at the reduction atmospheric CO2. Some transition metal polyphosphine complexes have been developed for this purpose. Likewise, further developments are searched for, to make the artificial process economically, commercially and energetically viable.

As with any groundbreaking technology, artificial photosynthesis faces challenges, including improving efficiency, scalability, and cost-effectiveness. However, the potential rewards are immense. If successful on a large scale, it could significantly reduce our carbon footprint, mitigate climate change, and usher in a new era of sustainable energy production. With an ever increasing concentration of CO2 and carbon footprint, lurking on our head, being able to recreate the natural way fuel "production" on a large, more directed scale could prove invaluable in our fight against the evil of climate change. As research in artificial photosynthesis advances, it offers a glimmer of hope for a more sustainable and eco-friendly future. The exciting world of artificial photosynthesis, thus brings with it, a light of hope while utilizing science, innovation, and nature converge to illuminate the path toward a cleaner, brighter tomorrow.

The Maillard Magic

Before I jump into the topic, I have some questions for my readers. Why does a toast taste better than a white bread slice or a golden brown dosa better than a homemade white dosa or a golden roasted potato better than a boiled mashed potato? Why is it that above a certain temperature cooking seems to produce astonishingly amazing aromas and gorgeous brown colour?

The smell of coffee, the unforgettable aroma of a bakery grilled meat or the brown spots on a chapati. It’s all the same family of chemical reactions named after a French chemist who had absolutely nothing to do with food named Louis Camille Maillard. His research focused on biological protein synthesis meaning how our bodies make up proteins and he happened to notice that sometimes sugars and amino acids which are the building blocks of proteins reacted together to produce something brown. As any food scientists will tell all cooking is chemistry but interestingly till the temperature goes above the boiling point of water most cooking involves no major chemical reactions. They are mostly physical changes like, starches and carbohydrates absorb water and swell in size no chemical changes, proteins denature meaning that they lose their three-dimensional structure and become harder still no chemical changes, fats don’t change at all in fact they remain fats till they get into our small intestine but once the temperature reaches 140 degrees Celsius interesting things start to happen to our food at this temperature. Melanoidins are responsible for the brown colour in various foods ,pyrazines contributes roasted and toasted aromas, thiazoles give a roasted and meaty aroma, furans impart a caramel like sweet and fruity aroma, aldehydes give a variety of aromas ranging from green and grassy to nutty and fruity ones, ketones contribute to buttery and creamy aromas oxazole provide meaty and savoury aromas. This goes on till about 170 degrees Celsius after which the longer we cook gives us byproducts of this reaction. They are harmful for example acrylamide is a substance that forms when certain foods, such as potatoes and grains, are cooked at high temperatures. It has been associated with health concerns. Regular consumption of starchy deep-fried foods comes with a lot of health hazards.

Heterocyclic amines and polycyclic aromatic hydrocarbons are typically produced when we grill, fry and barbeque meat at high temperatures Advanced glycation end products AGS sugars fats and protein can react at very high temperatures to produce molecules that have been linked with everything from diabetes to heart disease to Alzheimer’s .We need to master the Maillard reaction in our home kitchen to make food insanely delicious .If we are to make a dry dish there is already less water in the dish and as soon as most surface water evaporates from our ingredients they will start to brown to golden brown but not too dark brown at which point things become both bitter and unhealthy. Now how do we maximise Browning in a dry potato dish?

Potato is mostly water and is made of two kinds of starch amylose and amylopectin when we soak potatoes some of the amylopectin washes off and this is good because it will prevent the potato from sticking to each other in the pan. Now simply saut é the potatoes in oil and once salt is added that will further dehydrate the surface of the potato and we get pretty decent Browning but Maillard ninjas use another trick to make this process even more amazing .

Parboil the potatoes with tiny pinch of baking soda, plants contain pectin a kind of soluble fibre in their cell walls and in acidic meaning low pH conditions it forms a gel and we' re familiar with this texture because that' s how jams work pickled in

in fruits which tend to be slightly acidic sets into a jammy texture but baking soda is alkaline and that prevents the pattern from setting when we cook the potato and thus the surface of the potato now ends up having more grooves . Thus more surface area in cooking surface area is a very useful concept to understand more surface area equals faster evaporation of water from the surface this is how a Puri deep fries it loses moisture from its surface and the gluten traps the water that turned into steam inside the Puri causing it to puff up .

Browning onions as most of us will agree it is slightly frustrating, onions are 90% water and take forever to become ground and suddenly they start charging and become black and bitter in a very short amount of time. Properly caramelised onions take a lot of time which we usually do not have so we use the kitchen superhero again baking soda a very tiny pinch will get your onions brown in half the time that it takes otherwise but it will also make it slightly softer .So the key food science tips to master the Maillard reaction so far number one ; increase surface area number two; reduce surface water and dry stuff before cooking or adding salt to dehydrate faster and three; increase pH add baking soda .Thus Maillard reaction is everywhere it’s what makes delicious brown spots on your chapati the automatic brown crust on a bread in fact the addictive smell of a bakery the aroma of coffee chocolate grilled meat . Thanks to Maillard reaction for making food tastier and healthier.

WEEVIL BIOLUMINESCENCE

The bioluminescence of weevils is a fascinating natural phenomenon with a chemical basis. It involves a chemical reaction between two key components: luciferase and luciferin.

Luciferase: This enzyme is present in the weevil's body. It catalyzes the oxidation of luciferin.

Luciferin: Luciferin is a molecule that, when oxidized by luciferase, releases energy in the form of light. This reaction is facilitated by the presence of oxygen and other cofactors. The overall reaction can be simplified as follows:

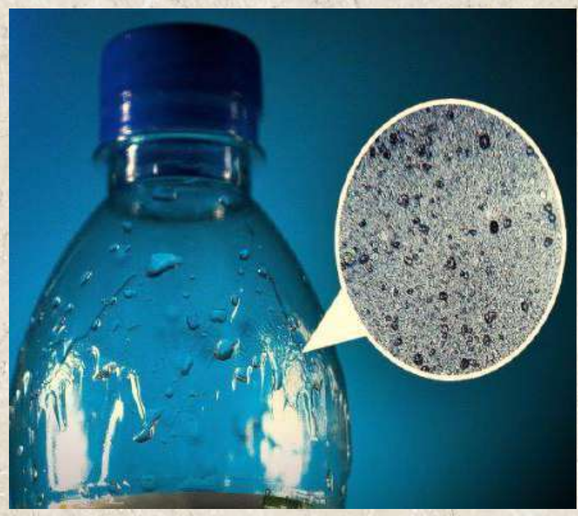
Luciferin + Oxygen + Luciferase → Oxyluciferin + Light

The emitted light is usually in the visible spectrum and is used by weevils for various purposes, such as attracting mates or deterring predators. The specific color and intensity of the light can vary between different species of weevils due to variations in the types of luciferases and luciferins they possess.

This bioluminescent process is similar to that of fireflies and some deep-sea creatures, although the exact chemical makeup of luciferin and luciferase can differ among these organisms. Bioluminescence in weevils is a remarkable example of how chemistry and biology interact to produce striking natural displays of light. Weevil Bioluminescence Chemistry

TOXICITY OF PACKAGED WATER

Leaching of Chemicals: Plastic bottles are typically made from polyethylene terephthalate (PET) or other plastics. Over time, these plastics can release small amounts of chemicals into the water, especially when exposed to heat or sunlight. This process is called leaching. Substances like phthalates and bisphenol A (BPA) can migrate from the plastic



into the water, potentially causing health concerns. BPA, for example, has been linked to hormonal disruptions.

Microbial Growth: If water is stored in a plastic bottle without proper cleaning and hygiene measures, it can become a breeding ground for microbes, including bacteria and algae.

These microorganisms can metabolize some of the compounds in the plastic and release metabolic by products, which can affect the taste and safety of the water. Chemical Reactions: In some cases, the water itself can undergo chemical reactions with components of the plastic. For

instance, exposure to sunlight can lead to the photo-degradation of plastic, producing free radicals that may react with water molecules or other substances in the environment.

To minimize these risks, it's advisable to:

Use food-grade plastic bottles designed for repeated use. Avoid exposing the bottles to extreme temperatures or prolonged sunlight. Regularly clean and sanitize the bottles. Consider using alternatives like stainless steel or glass containers for long-term water storage.

FERTILIZATION OF PONDS

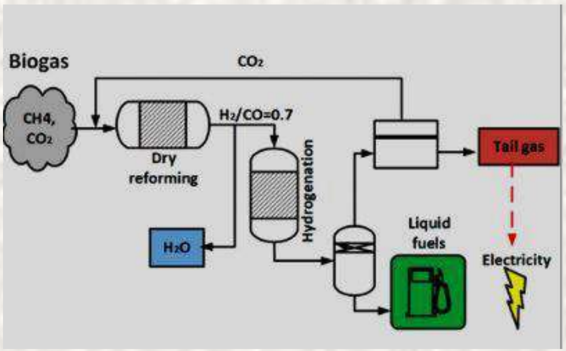
Buffering pH: Calcium carbonate acts as a pH buffer. It can neutralize acidic substances in the pond water, preventing rapid fluctuations in pH. This stability is crucial for maintaining a suitable environment for aquatic life. When acidic substances, such as decaying organic matter, release hydrogen ions (H^+), the carbonate ions (CO_3^{2-}) from calcium carbonate can react with them to form bicarbonate ions (HCO_3^-) and raise the pH, helping to maintain a more alkaline and stable pH level.

Calcium Source: Calcium is an essential mineral for aquatic organisms, particularly for the development of shells and skeletons in many aquatic species like mollusks and some algae. By adding calcium carbonate, you ensure that calcium ions (Ca^{2+}) are available for these organisms to build and maintain their structures.

Potassium Source: Potash serves as a source of potassium ions (K^+). Potassium is another essential nutrient for aquatic plants and some microorganisms. It plays a role in various biological processes, including enzyme activation and osmotic regulation. Calcium carbonate ($CaCO_3$) dissolves in water to form calcium ions (Ca^{2+}) and carbonate ions (CO_3^{2-}). The carbonate ions can react with acidic substances in the water to increase pH, as mentioned earlier. $CaCO_3 (s) \rightarrow Ca^{2+} (aq) + CO_3^{2-} (aq)$ Potash (K_2CO_3) dissolves to release potassium ions (K^+) and carbonate ions (CO_3^{2-}): $K_2CO_3 (s) \rightarrow 2K^+ (aq) + CO_3^{2-} (aq)$. Overall, adding calcium carbonate and potash to pond water helps stabilize pH, provides essential nutrients (calcium and potassium), and supports the overall health and balance of the aquatic ecosystem.

THE GENERATION OF ELECTRICITY FROM BIOGAS

Biogas Formation: Biogas is typically produced through the anaerobic digestion of organic materials like animal manure, sewage, agricultural waste, and food scraps by microorganisms in an oxygen-free environment. The main components of biogas are methane (CH4) and carbon dioxide (CO2), with trace amounts of other gases like hydrogen sulfide (H2S).



Combustion of Methane: To generate electricity from biogas, the methane in biogas is burned in a combustion chamber. The chemical reaction for the combustion of methane is:

CH4 (g) + 2O2 (g) → CO2 (g) + 2H2O (g) + Energy

This reaction releases heat energy, which can be harnessed to generate electricity.

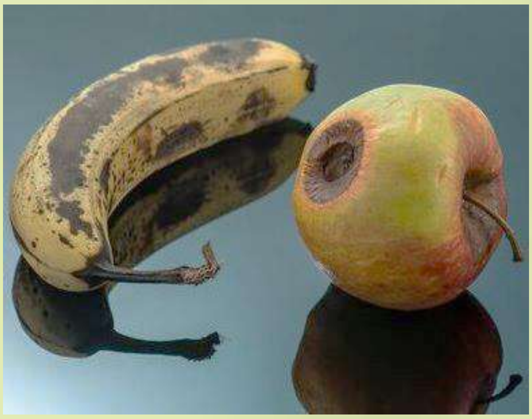
Electricity Generation: The heat produced during methane combustion is used to produce steam in a boiler. The high-pressure steam then drives a turbine connected to a generator. As the steam

passes through the turbine, it causes the turbine blades to spin, which, in turn, rotates the generator. This mechanical energy is converted into electrical energy through the generator's electromagnetic processes.

Generation of Electricity: The generator contains coils of wire within a magnetic field. When the turbine spins the generator, it induces a flow of electrons in the wire coils, creating an electric current. This current can be harnessed as electrical power.

BROWNING PROCESS OF FRUITS AFTER GETTING CUT

Polyphenols: Bananas, like many fruits, contain natural compounds called polyphenols. These polyphenols include phenolic compounds like catecholamines and polyphenolic compounds such as catechol. These compounds are normally found within the cells of the banana.



Enzyme Polyphenol Oxidase (Tyrosinase): Polyphenol oxidase is an enzyme present in banana cells. When the banana is damaged, cut, or bruised, it disrupts the cell structure and releases the enzyme.

Oxidation Reaction: Polyphenol oxidase catalyzes an oxidation reaction. It converts polyphenols (such as catecholamines and catechol) into quinones. This reaction involves the removal of oxygen from the polyphenol molecule and its transformation into a highly reactive quinone compound.

Polyphenol (e.g., catechol) + Polyphenol Oxidase → Quinone

Quinone Reaction: The quinone compounds are highly reactive and can further react with proteins and amino acids present in the skin or on your hands. This reaction results in the formation of dark-colored compounds, often brown or black pigments, through a series of chemical reactions.

Quinone + Proteins/Amino Acids → Dark-Colored Pigments

These dark-colored pigments are responsible for the blackening or browning effect on your skin or hands when they come into contact with banana sap containing the enzyme polyphenol oxidase.

Quiz Section

মগজাস্ত্র

1. I was mentioned in the the Sherlock Holmes story, The Adventure of the noble bachelor, where a solution of mine was used to identify the presence of blood stains. My hydrated salts were the reason, you get to study a class of inorganic compounds, mostly made up of transition elements. Can you name me? (6 letters)

2. The Entire premise of the famous series, Breaking Bad revolves around the illegal manufacture and distribution of this chemical compound. The chemical process of producing this was the recurring theme throughout the show. Can you name the compound ? (15 letters)

3. This was the most powerful and dangerous acid invented by Professor Shonku. This acid was used in a special pistol as well. Can you name it? (9 letters)

4. I was the first ever graduate to have done my graduation in science, specializing in chemistry, from an Indian University(University of Calcutta). Though most of my works in my research life were based on plants and plant science, my earlier works usually dealt with the chemistry of plants. Can you name me?

5. A.P.C. Ray's groundbreaking research in organic chemistry led to the synthesis of this compound, also known as Ray's salt. A compound that found applications in medicine. His meticulous work in this area garnered international recognition and acclaim. What is the name of the compound?

6. This chemical is used in the process of converting pseudoephedrine into methamphetamine in the series, Breaking Bad. This is a very common compound, often used for certain organic reactions, as a reagent, one such reaction being the transformation of Organic Alcohol into Unsaturated Hydrocarbons. Can you name the chemical?

7. Named after Prometheus, the Greek Titan who stole fire from the gods to give it to humanity, this element is a relatively rare and radioactive element. Identify the element. (10 letters)

8. He is an Indian-American structural biologist, who was jointly awarded the Nobel Prize in Chemistry in 2009 for his significant contributions to the field of structural biology,

Answers:

1) Cobalt
2) Methamphetamine
3) Annihilin acid
4) Acharya Jagadish Chandra Bose
5) Mercurous Nitrite
6) Red phosphorus
7) Promethium
8) Venkatraman Ramakrishnan

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