



Boson is an annual newsletter founded by the Department of Chemistry, Pragjyotish College in 2016. The name chosen in the honour of S.N. Bose who discovered the fundamental particle "BOSON". This is not only a purely newsletter but it also features articles based on significant and path breaking discoveries. It includes a common article on the Nobel Prize in Chemistry each year. The current issue incorporates a column featuring an interview with an eminent Scientist,



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THE NOBEL PRIZE IN CHEMISTRY 2020

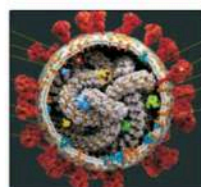
The Nobel Prize is regarded as the most prestigious awards given for intellectual achievement in the world are awarded annually from a fund bequeathed for that purpose by the Swedish inventor and industrialist Alfred Nobel.

This award is announced every year for excellence in Physics, Chemistry, Medicine, Literature, Economics, and a distinguished achievement towards humanity- commonly known as ... (Page No. 8)



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PROFILE

The glorious journey of the department of Chemistry, Pragyotish College has been started in 1960. Although there were various ups and downs, this department could maintain harmony with the students in terms of their needs. In recent years, the department has been organizing various events for the development of the students in all respects. The increasing number of students opting for higher education and accordingly their ability to secure seats in different eminent institutes reflect departmental success. The creation of a research environment at the undergraduate level is another valued addition to the department. This will help the stakeholders of the department to cope up with NEP 2020 immediately after implementation. Currently, the department has 6 (six) permanent faculties and one Guest faculty with three laboratory bearers. Due to the high demand of the subject, the number of students taking admission is increasing significantly.

Among the activities jointly performed by the teachers and students under the forum "Dhatu", releasing wall magazine PSI and publishing departmental annual newsletter BOSON are two major outcomes to the society. This year the department is going to publish the 5th volume of BOSON and release the 8th volume of modified and updated PSI. These two reflect the creativity of students and give them the opportunity to articulate their scientific thinking. This volume of PSI depicts the importance of GREEN concepts in chemistry. The current volume of BOSON tries to incorporate the recent advances in the field of science and technology, also an interview with the Bhatnagar Awardee Dr. Binoy Kr Saikia, Scientist, CSIR-NEIST, Jorhat.



Photo: Department of Chemistry
Pragyotish College, Ghy-09

ACHIEVEMENTS



Abhik Bordoloi
Cleared JAM 2021 with rank 734, (best ever from department)



Jagrata Sarma
Cleared JAM 2021, GUEE (Rank 12), Cleared CUCET, RGUCET. Studying M.Sc. in GU



Mritul Kalita
Cleared GUEE (Rank 13), CUCET and RGUCET Studying M.Sc. in GU



Pritam Boro
Cleared GUEE, CUCET and RGUCET Studying M.Sc. in B Barooah College.



Shrabana Chakrabarty
Cleared GUEE Studying M.Sc. in Handique Girls College



Jyotshna Hujuri
Cleared GUEE, CUCET Studying M.Sc. in Handique Girls College



Manisha Das
Cleared GUEE Studying M.Sc. in B. Barooah College



Dilruba Hussain
Cleared GUEE Studying M.Sc. in Handique Girls College



Amartho Debrade
Cleared GUEE Studying M.Sc. in GU



Niloy Pratim Kashyap
Studying M.A. in Sociology, Cotton University



Poly Mandal
Studying M.Sc. in Environmental Science, GU

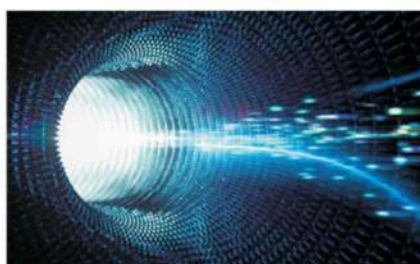


Kamal Krishna Sharma
Studying MSc in Environmental Science, GU

Application of Quantum Tunneling

■ Mritul Kalita

In semiconductor devices such as electronic circuit components or integrated circuits that are designed at nanoscales, Quantum tunneling has numerous applications. For example, a diode can be realized by a tunnelling junction between two different types of semiconducting materials. Electrons tunnel through a single potential barrier at a contact between two different semiconductors in such a tunnel diode. At the junction, tunnelling electron current changes nonlinearly with the applied potential difference across the junction and may rapidly decrease as the bias voltage is increased unlike the Ohm's Law. In high speed electronic devices, this kind of rapid behaviour caused by quantum tunneling is desirable. Quantum dot is an electronic device which utilizes resonant tunneling of electrons through potential barriers. It's a small region of a semiconductor nanocrystal that is grown. For example, Aluminium arsenide crystal. In which a quantum dot of gallium arsenide is embedded in aluminum arsenide water as shown in the figure below. The quantum dot region acts as a potential well of finite height potential barriers at dot boundaries. Thus, a quantum dot of gallium arsenide sitting in



(Source: Google)

aluminum arsenide is a potential well and low-lying energies of electrons are quantized (E_{dot}). When the energy ($E_{electron}$) of an electron in the outside region of the dot does not match its energy E_{dot} that it would have in the dot. The electron does not tunnel through the region of the dot and there is no current through such a circuit element, even if it were kept at an electric voltage difference (bias). However, when this voltage bias is changed in such a way that one of the barriers is lowered, so that E_{dot} and $E_{electron}$ become aligned, an electron current flows through the dot when the voltage bias is increased, this alignment is lost and the current stops flowing. When the voltage bias is increased further, the electron tunneling becomes improbable until the outside electron energy matches the next electron energy level in the dot. Resonant-tunneling diodes are used as super fast nano-switches.

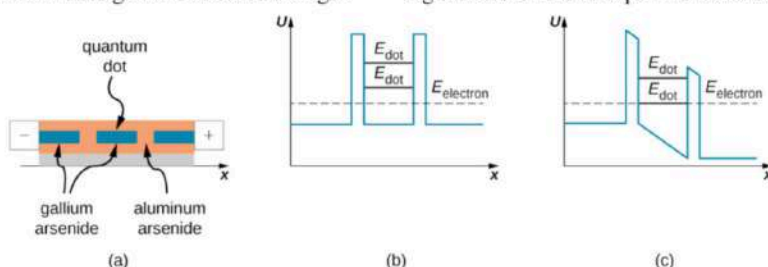


Figure: Resonant-tunneling diode

- A quantum dot of gallium arsenide embedded in aluminum arsenide.
- Potential well consisting of two potential barriers of a quantum dot with no voltage bias. Electron energies $E_{electron}$ in aluminum arsenide are not aligned with their energy levels E_{dot} in the quantum dot, so electrons do not tunnel through the dot.
- Potential well of the dot with a voltage bias across the device. A suitably tuned voltage difference distorts the well so that electron-energy levels in the dot are aligned with their energies in aluminum arsenide, causing the electrons to tunnel through the dot.

Rain! That too, Artificial!

We all know how the process of rain works, starts from evaporating of water, travels upstream as the wind rises high in the troposphere causing some drops to merge and when the thickness of the drops come in the vicinity of 0.1mm they can't float up there and finally we get bestowed by the almighty rain.

Artificial rain or increase rain, that is produced by seeding clouds artificially with 'dry ice' (frozen carbon dioxide), silver iodide, potassium iodide or other appropriate particles, which acts as condensation nuclei. The stimulation is done by aeroplanes or rockets the idea of this artificial rainfall has a long history.



(Source: Google)

In 1981, LOUIS GATHMANN was the first who suggested shooting CO₂ (liq.) into rain clouds to cause rainfall. And the first experiment of cloud seeding was conducted in 1946 by American chemist & meteorologist. Since then seeding has been performed. In India also it was conducted by Tamilnadu, Karnataka govt. In 2021, UAE has done cloud seeding using a new method by charging clouds with electricity.

■ Rupam Kalita
3rd Semester

FACTS

- The solid form of carbon dioxide is known as the dry ice.
- Hot water freezes quicker than cold water.
- The surface of Mars is red because of the presence of iron oxide.

Biomolecules and you!

A living system grows sustains and reproduces itself. The most amazing thing about living organisms (for eg: human body) is that it is composed of non living atoms or molecules known as biomolecules. The human body thus is made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. Proteins and carbohydrates are essential constituents of food. In addition, some simple molecules like vitamins and mineral salts also play an important role in the functioning of the human body. The functions of some of these biomolecules are discussed below:

Carbohydrates
(monomer: monosaccharides)
Function:
Provide material to build cell membrane, energy for cell.
Food source:
Pastas, breads, fruits, vegetables.
Example:
Glucose, fructose, lactose, cellulose.

Proteins
(monomer: amino acids)
Function:
Provide structure, aid in muscle movement provide immunity.
Food source:
Seafood, milk, eggs, meat, cheese.
Example:
Insulin, haemoglobin, enzymes, antibodies.

Nucleic acids
(monomer: nucleotides)
Function:
contains genetic information, directs growth and development
Example:
DNA, RNA

Lipids
(Monomer: Glycerol, fatty acids)
Function:
Store energy, material used for cell Membrane.
Food source:
Butter, nuts, oil.
Example:
Fats, oils, waxes.

■ Ripunjoy Deka
3rd Semester

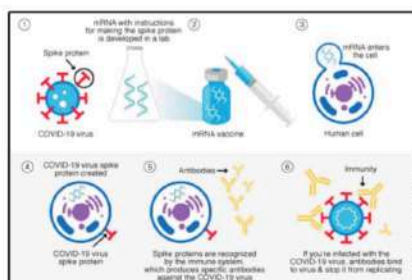
ACTION OF COVID 19 VACCINES

Coronavirus disease 2019 (COVID-19 or coronavirus) was first detected in December 2019 by health authorities in Wuhan City in the People's Republic of China. Since that time, more than 25,36,40,693 cases have been confirmed worldwide, and the virus has spread to more than 114 countries across 6 continents, causing over 51,04,899 deaths to date, according to the World Health Organization (WHO). Spread of the coronavirus has caused a global emergency. It has been characterized as an "epidemic" by the US Centers for Disease Control and Prevention (CDC) and the WHO raised the status to that of a "pandemic"—an infectious disease that is able to infect people easily and spread from "person to person in an efficient and sustained way," according to the CDC.

Due to its peculiar nature of hijacking human cell machinery to blunt the immune response, which allows it to establish infection, replicate, cause disease and due to RNA being its genetic material, a definite cure was almost unachievable in the tight deadline that was set for the task. In March, 2020 NIH reported that a phase 1 clinical trial evaluating an investigational vaccine designed to protect against COVID-19 has begun at Kaiser Permanente Washington Health Research Institute (KPWHRI) in Seattle. It was the very first effort for development of the vaccine and due to countless trial and errors of many such institutions and pharmaceutical companies till date over 200 different vaccines were developed and more than 50 had undergone human phase [phase-3]. Having so many vaccines developed increases the chances of being effective in the intended populations, reduces the chances of monopolization of doses and reduction of effectiveness due to sudden mutation in the virus (formation of a new variant)

Response of body towards a pathogenic body

When a pathogen enters our body, at first it is encountered by the body's defence mechanism i.e. the white blood cells and cause it to react and eliminate the external entity. Each pathogen is made up of several subparts, usually unique to that specific pathogen and the disease it causes. The subpart pathogen that causes the formation of antibodies is



called an antigen. The antibodies produced in response to the pathogen's antigen are an important part of the immune system. When the human body is exposed to an antigen for the first time, it takes time for the immune system to respond and produce antibodies specific to that antigen. Once the antigen-specific antibodies are produced, they work with the rest of the immune system to destroy the pathogen and stop the disease. Once the body produces antibodies in its primary response to an antigen, it also creates antibody-producing memory cells, which remain alive even after the pathogen is defeated by the antibodies. If the body is exposed to the same pathogen more than once, the antibody response is much faster and more effective than the first time around because the memory cells are at the ready to pump out antibodies against that antigen.

Gaurav Jyoti Dutta
3rd Semester

This means that if the person is exposed to the dangerous pathogen in the future, their immune system will be able to respond immediately, protecting against disease.

Vaccines contain weakened or inactive parts of a particular organism (antigen) that triggers an immune response within the body. Newer vaccines contain the blueprint for producing antigens rather than the antigen itself. This weakened version will not cause the disease in the person receiving the vaccine, but it will prompt their immune system to respond much as it would have on its first reaction to the actual pathogen. Some vaccines require multiple doses, given weeks or months apart. This is sometimes needed to allow for the production of long-lived antibodies and development of memory cells. In this way, the body is trained to fight the

specific disease-causing organism, building up memory of the pathogen so as to rapidly fight it if and when exposed in the future.

There are mainly three processes by which a vaccine is developed.

mRNA vaccines contain material from the virus that causes COVID-19 that gives our cells instructions for how to make a harmless protein that is unique to the virus. After our cells make copies of the protein, they destroy the genetic material from the vaccine. Our bodies recognize that the protein should not be there and build T-lymphocytes and B-lymphocytes that will remember how to fight the virus that causes COVID-19 if we are infected in the future.

Protein subunit vaccines include harmless pieces (proteins) of the virus that causes COVID-19 instead of the entire germ. Once vaccinated, our bodies recognize that the protein should not be there and build T-lymphocytes and antibodies that will remember how to fight the virus that causes COVID-19 if we are infected in the future.

Vector vaccines contain a modified version of a different virus than the one that causes COVID-19. Inside the shell of the modified virus, there is material from the virus that causes COVID-19. This is called a "viral vector." Once the viral vector is inside our cells, the genetic material gives cells instructions to make a protein that is unique to the virus that causes COVID-19. Using these instructions, our cells make copies of the protein. This prompts our bodies to build T-lymphocytes and B-lymphocytes that will remember how to fight that virus if we are infected in the future.

Because COVID vaccines have only been developed in the past months, it's too early to know the duration of protection of COVID-19 vaccines. Research is ongoing to answer this question. However, it's encouraging that available data suggest that most people who recover from COVID-19 develop an immune response that provides at least some period of protection against reinfection – although we're still learning how strong this protection is, and how long it lasts. But we should not take the matter so lightly and should get vaccinated as soon as we can.



Photo: Launching event of
Dhatu new logo
Dated 5th December, 2020



Photo: Inauguration event of
Wall-Magazine 2020
Dated 5th December, 2020

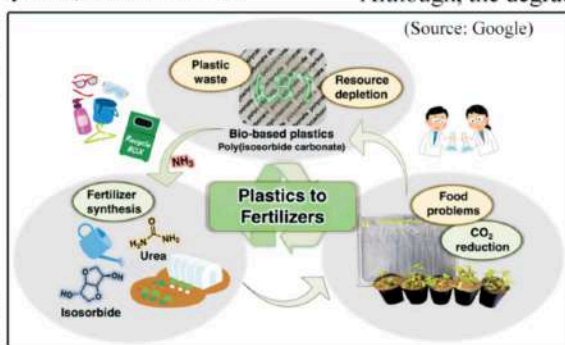


Photo: Publishing event of new edition of
"BOSON - an annual newsletter Volume 4 Issue 1"
Dated 5th December, 2020

Bioplastic! What's that?

Plastics have taken the world by storm over the last century, finding applications in every aspect of our lives. However, the rise of these synthetic polymers, which form the basis of plastics, has contributed to many serious environmental issues. The worst of these is the excessive use of petrochemical compounds and the disposal of non-biodegradable materials without recycling; only 14% of all plastic waste is recycled, which hardly puts a dent in the problem.

Scientists of Tokyo Institute of Technology developed a way to solve the plastic conundrum in a circular system in which the source materials used to produce the plastics come full circle after disposal and recycling. In their new environmentally friendly process, plastics produced using biomass (bioplastics) are chemically recycled back into fertilizers. The team focused on poly (isosorbide carbonate), or "PIC," a type of bio-based polycarbonate that has garnered much attention as an alternative to petroleum-based polycarbonates. PIC is produced using a non-toxic material derived from glucose called isosorbide (ISB) as a monomer. The interesting part is that the



carbonate links that join the ISB units can be severed using ammonia (NH₃) in a process known as 'ammonolysis'. The process produces urea, a nitrogen-rich molecule that is widely used as a Fertilizer.

Although, the degradation of PIC was not complete even after 24 hours, with many ISB derivatives still present. Therefore, the researchers tried increasing the temperature and found that complete degradation could be achieved in about six hours at 90°C. The benefits of this approach is that, "The reaction occurs without any catalyst, demonstrating that the ammonolysis of PIC can be easily performed using aqueous ammonia and heating. Thus, this procedure is operationally simple and environmentally friendly from the viewpoint of chemical recycling." Further, it has been observed that plants treated with all PIC degradation products grew better than plants treated with just urea. The overall result showcases the feasibility of developing fertilizer-from-plastics systems. The systems can not only help fight off pollution and resource depletion but also contribute to meeting the world's increasing food demands.

Dibyendu Rakshit
3rd Semester

Tannins and human health

Tannins (commonly referred to as tannic acid) are water-soluble polyphenols that are present in many plant foods. They have been reported to be responsible for decreases in feed intake, growth rate, feed efficiency, net metabolizable energy, and protein digestibility in experimental animals. Therefore, foods rich in tannins are considered to be of low nutritional value. Incidences of certain cancers, such as oesophageal cancer, have been reported to be related to consumption of tannins-rich foods such as betel nuts and herbal teas, suggesting that tannins might be carcinogenic.

Tea polyphenols and many tannin components were suggested to be anticarcinogenic. The anticarcinogenic and antimutagenic potentials of tannins may be related to their antioxidative property, which is important in protecting cellular oxidative damage, including lipid peroxidation. The generation of superoxide radicals was reported to be inhibited by tannins and related compounds. The antimicrobial activities of tannins are

The growth of many fungi, yeasts, bacteria, and viruses was inhibited by tannins. We have also found that tannic acid and propyl gallate, but not Gallic acid, were inhibitory to food borne bacteria, aquatic bacteria, and off-flavour-producing microorganisms. Their antimicrobial properties seemed to be associated with the hydrolysis of ester linkage between Gallic acid and polyols hydrolyzed after ripening of many edible fruits. Tannins in these fruits thus serve as a natural defence mechanism against microbial infections. Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level, produce liver necrosis, and modulate immunoresponses.

Joyshree Deka
3rd Semester

How the sun burns yet it does not use oxygen?

The sun is an amazing source of energy and people have long wondered how all that energy is produced. The word burning usually means combustion and if the sun was burning this way, it would instead need oxygen, but it does not need oxygen to burn. Actually the burning of the sun is not chemical combustion, it is a nuclear fusion.

The sun is considered as a giant hydrogen bomb. In the nuclear fusion, the nuclei of atoms are fused together to make new, bigger nuclei. Since, the nucleus of an atom determines what the atom is and how it behaves; a change to the nucleus causes the atom to become a new element. Two hydrogen atoms fuse together to make one helium atom. Nuclear fusion does not require oxygen. In fact, it does not need any other material at all. It just needs enough pressure or heat to squeeze the nuclei of the atoms close enough that they overcome their electrostatic repulsion and bond into a single nucleus. In stars like sun, the intense pressure and temperature are provided by gravity. A star has large mass that the gravity created by this mass crushes the star inward enough to ignite nuclear fusion. Nuclear fusion in stars releases immense amount of energy, which we ultimately experience as sunlight. The sun has a core temperature of 16 million Kelvin and a core pressure of 25 thousand trillion Newton per square meter. The sun gets so hot from its nuclear fusion that it glows and emits light.

There are two main forces at work in nuclear fusion. The electromagnetic force and the strong nuclear force. The repulsive electromagnetic force between positively charged nuclei is long range but relatively weak, while the attractive strong nuclear force is short range but strong. When two nuclei are far enough apart, the repulsive electromagnetic force dominates, holding the nuclei apart. As the two nuclei get closer, the electromagnetic repulsion gets stronger and it gets harder and harder to push the nuclei together. When the two nuclei gets close enough, the attractive short range nuclear force dominates and the two nuclei stick together to form a new nucleus. For this reason, it takes a lot of pressure to push nuclei close enough that they fuse together.

In stars like sun, most of the fusion taking place is hydrogen fusing with itself or with other light elements. Since gravity is what provides the pressure of to ignite caused by mass, all it is needed is a big enough mass of hydrogen in order to end up with burning stars.

Jyotiprashad Das
5th Semester



Dr. Binoy Kr. Saikia
 Scientist
 CSIR-NEIST Jorhat,
 Assam

“Everyone should do their job as Passion not as Profession”

- An Interview with Dr. Binoy Kr Saikia

Shanti Swarup Bhatnagar Prize is most prestigious award in the field of science & technology in India. Every year this prize is given to the scientist/researcher who contributes on the fields of science & technology. In 2021 Dr. Binoy Kr. Saikia received this award in the field of earth and atmospheric science and he is the 5th Assamese to receive this award and 1st scientist working in Assam. He is a scientist in CSIR-NEIST Jorhat, Assam.

A team of Department of Chemistry, in the leadership of Dr. Saitanya Kr. Bharadwaj along with Radhika Mishra, Gītartha Kalita and Churamoni Bharali took a telephonic Interview with the esteemed scientist.

Herewith we are presenting the conversation in a written format.

Our team: First, we congratulate you for the achievement. You have brought pride to our region with your scientific discovery. Sir, can you tell us something about your initial days of schooling and what brought about your curiosity towards science?

Dr. Saikia: I completed my schooling from Don Bosco School, Sarupathar and then I moved to Debraj Roy College, Golaghat to complete my H.S. and graduation. Various experiences made me curious about science, to mention a few, enjoying different types of colors in pre-school, and also desire to know the reason behind seawater being salty. Such experiences raised my curiosity towards the subject of science.

Our team: Can you elaborate how you came to this position?

Dr. Saikia: After I completed M.Sc. from Cotton College, Guwahati in 2001, I joined as a research scholar in CSIR-NEIST (CSIR-North East Institute of Science and Technology), formerly RRL. I worked on the electron density of carbon in coal and then got my PhD. Then I moved to Tezpur University, Haldia refinery and now finally I am working as a scientist in CSIR-NEIST.

Our team: What advice do you wish to give the students on self-motivation?

Dr. Saikia: Firstly, motivation is very important for a person to get success or to reach the goal, and motivation comes from the seniors, teachers as well as parents. But being self motivated is most important. If there is no self motivation in any field like science, arts or commerce; the things does not go as your way and which is lacking in many of the students nowadays. If a person is self motivated, or you can say, focused towards their goals they will definitely have their way towards success. One can get self-motivation by asking oneself where he or she is ahead off.

Our team: You have developed a process of extraction of Carbon Quantum Dot (CQD) for the 1st time from Indian coal. So can Coal be used as the source of CQD?

Dr. Saikia: If there is a need for tons of nano-materials, India will not be able to meet the requirements due to non-availability of feed materials; whereas our neighboring country China is capable to do so, as we don't have a large scale process.

We are working on a low scale because we don't have proper raw & cheap materials. So, coal could be served as a raw material for producing CQD in a large scale. Cost of CQD is pretty high when bought from countries like US, China, Japan. But, in India if we start producing CQD from coal, it can help in boosting the economy as we can get coal at a cheap price which is abundant. You can say, it will promote Aatmanirbhar Bharat.

Our team: Now, can you tell us about the scopes in Carbon Quantum Dot? Should a student opt for researching on Carbon Quantum Dots (CQD)?

Dr. Saikia: Yes, this is a good question. As you know our focus was on finding an alternative for the utilization of coal, because coal emits toxic gases such as SO₂, CO₂, CO, CH₄ etc.

If the developed countries stop burning coal, there should be some other ways to use these natural energy resources which was our purpose of research, and then we found that coal can be converted into CQD. CQD is more futuristic and interesting than graphene because CQD is non toxic like other metallic nano-materials. After researching I can say that there is lot to explore in this project, and in the future I think CQD have the potential to take all the application of nano-materials.

Our team: What is the funniest or the most memorable thing that has happened in your journey?

Dr. Saikia: One of the most memorable things in my life is the extraction of CQD from coal serendipitously. While working on removal of sulfur from coal as the coal found in North-East India have high sulfur content and cannot be utilized for electricity production or combustion. It has been for more than 50 years but nobody succeeded. So we are also working for removal of sulfur by using ultrasonic energy. One evening, while working we got some material which is fluorescent. My student informed me that “Sir, I got a material and on UV light exposure it gives a blue fluorescent”. Then I told him that there should be some nano particles, so you just go for the electron microscope study, but the funniest thing is that we did not have an electron microscope in our institute at that time. So we went to

Shillong, after 2-3 months in NEHU we got an electron microscope to study and we got some image of nano-particles. But the funniest thing is that we couldn't interpret those electron images and kept on studying it for 2-3 months. We discussed with our students and other experts but nobody could relate it to quantum dot. Then we studied, compared with literature and came to know that those particles are CQDs. So it was a fortunate incident that we observed the fluorescent in our laboratory that evening. Later we got to know that USA Rice University published a similar paper on Carbon Quantum Dots from coal. So, in India we are the first who have extracted the CQD from coal.

Our team: Sir how is your life being a researcher or a scientist. Like, what are the things you came across as being one?

Dr. Saikia: So for me, being a Scientist or a researcher means to be in touch with my students, like to talk about the things with other researchers and so on. The most important thing for a scientist or a researcher is that, we like to spend our time in the laboratory, which I also consider as my 'second home' because we stay in the laboratory for minimum 10 hours a day.

In addition to this, the most important thing is that research is a continuous process; there is no end to this and if, one is a scientist or researcher, they should not take their work as a Job; instead they should take it as their passion. Then only, an organization or a country will develop.

Our team: Do you have any particular hobbies except from doing new researches?

Dr. Saikia: I like to read books and novels, and whenever I get time I like to read autobiography of great people also, I started reading when I was in class 10 and I was the first subscriber of a divisional library in Sarupathar, Golaghat. The autobiography of Abraham Lincoln is my favorite book.

Sir, thanking you for your valuable time. We thank and hope that your valuable words will inspire many. We are eager to have you in our college for an interactive program with students in the near future.



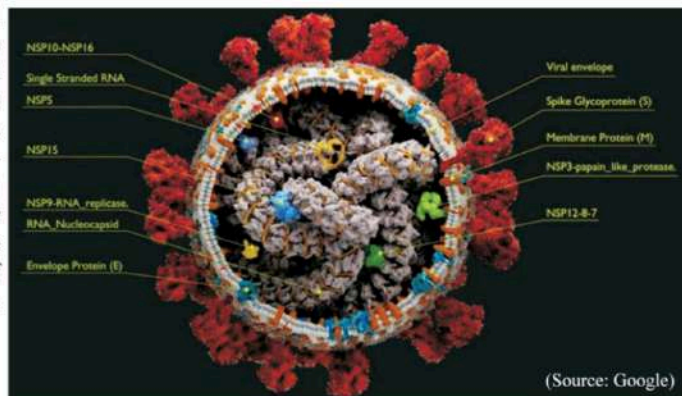
Chemistry Behind The Attack of Corona Virus

COVID-19 (Corona Virus Disease 2019) is an infectious disease caused by the novel severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2). It has developed into a global pandemic over a course of few months. The transmission electron microscopic (TEM) of SARS-CoV-2 inside a cell displays spherical viral particles that are colorized in blue. The virus comprises of three basic building blocks: a single-stranded RNA genome, viral membrane composed of lipid-bilayer and surface proteins. The RNA genome is composed of 30000 nucleotides and it encodes four structural proteins namely: Nucleocapsid (N) protein, Membrane (M) protein, Envelop (E) protein, Spike (S) protein, and many non-structural proteins (nsps). The nucleocapsid protein helps in the formation of nucleocapsid to protect the genome. The nucleocapsid is formed by packaging the viral RNA genome into a ribonucleoprotein complex. The M-protein is the most copious in the viral surface and its key role is to support viral assembly as a central organizer. The E-protein is the smallest membrane protein comprising of approximately 76–109 amino acid residues and it has a crucial role in virus assembly, envelope formation, membrane permeability of the host cell and virulence. The S protein is an important structural trans-membrane protein comprising of 1200–1400 amino acid residues on the outer envelope of the virus. The S protein is responsible for virus entry as it recognizes the specific host-receptors

located on the human cell surface. S protein exists as a self-assembled homotrimer in which each of the monomers is composed of two functional units-S1 and S2. S1 subunit is accountable for host recognition whereas the S2 subunit is in charge of host-guest membrane fusion

Ankita Phukon
3rd Semester

The N-terminal domain of S1 subunit is considered as carbohydrate recognition domain and the C-terminal domain is called receptor-binding domain (RBD) as it supports host-guest interaction and responsible for virus entry by recognizing protein receptors of the infected lung cells. The S protein mediates the virus entry into the cell by binding its receptor, followed by fusion and endocytosis. So, the virus has spike protein that recognizes human cell receptor namely ACE2. Fusion occurs at a low pH between viral and host target membranes via S2 subunit. After the entry, the viral genome a single-stranded RNA is launched into the cytoplasm and translated into two large polypeptides which are fragmented and transformed into mature non-structural proteins by the two viral proteases 3CLpro (3 C-like protease or main protease) and PLpro (papain-like protease). Also,



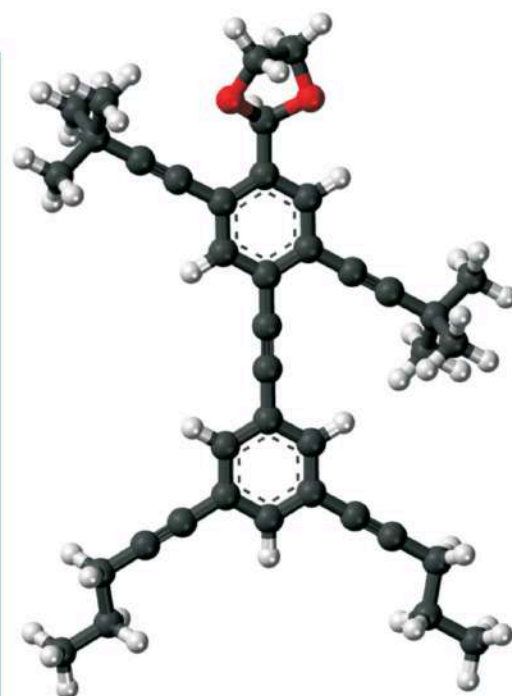
the RNA replication occurs producing multiple copies of genome and the process is mediated by the viral replication complex, including the RNA-dependent RNA polymerase (RdRp), helicase, and other accessory proteins. Structural viral proteins such as M, S and E-proteins are synthesized in the cytoplasm and then placed to endoplasmic reticulum-Golgi intermediate compartment. Hence, plenty of these building blocks are formed in a virus-infected cell and spontaneously self-assemble to generate new viruses. Finally, these viruses are exported from the infected cell through a process called exocytosis and infect other cells. Basically, the virus has a spherical supramolecular structure in which all the building blocks are associated by weak non-covalent interaction. Hence very mild chemicals such as soap/detergent are enough to split the units and destroy the virus.

CHEMISTRY OF HUMAN EYE

Vision is such an everyday occurrence that we rarely stop to think, HOW DO WE SEE OBJECTS? The answer to that question is the organic compound, retinal, present in our retina which converts visible light into nerve impulses. In the human eye, retinal begins in an 11-cis-retinal configuration, which upon capturing a photon of the correct wavelength, straightens out into an all-trans-retinal configuration. This configuration change pushes against an opsin protein (opsins are proteins and retinal binding pigment present in the Photoreceptor, rod cells, of the retina) and changes its configuration. As the protein changes its geometry, it initiates a cascade of biochemical reactions that results in changes in charge so that a large potential difference builds up across the

plasma membrane. This potential difference is passed along to an adjoining optic nerve cell as an electrical impulse. The nerve cell carries this impulse to the brain, where the visual information is interpreted. The absorbance spectrum of the chromophores depends on its interactions with the opsin protein to which it is bound, so that different retinal-opsin complexes will absorb photons of different wavelengths (i.e., different colours of light).

Rikita Das Gupta
3rd Semester



NanoPutian
Chemical Formula: $C_{39}H_{42}O_2$

Chemistry behind perfume

Niha Saha
5th Semester

Perfume is a mixture of fragrant oils, fixatives or solvents, aroma compounds which give a pleasant scent or smell. The word perfume was derived from the Latin word *parfumare*, which means "to smoke through".

Chemistry of perfume

Most perfumes compose of a three part structure. The first olfactory impression of the perfume conveys which is "Head" also known as the "Top". The second is the "heart" which is the fragrance that lasts for several years. The last is the "base", which is the fragrance underpinning the full perfume and its components of least volatile chemicals. These parts make the fragrance last for days.

Role of chemistry

A smell is a molecule that floats in the air that is very light enough. Fragrance material used is generally semi volatile organic compounds and their molecular weight barely exists. However, not every molecule floating in air are recognised by human nose. For example, carbon monoxide. How a perfume smells is not dependent upon what it comes from but also on how an individual is chemically connected to perceive it. Chemical reaction caused by light can also morph the smell of your perfume, as the energy present in light can break down the bonds present in molecules of the fragrance. Bright sunlight can damage your perfume. So, the best place to keep perfume is in the dark place at room temperature.



Photo: Wall Magazine 2020

Chemistry and space travel have always been inextricably linked to each other. Since the first moon mission and also in the construction of rockets chemists have always made a most visible role in space travel. The vehicles used in space orbits require a heat-resistant thermal coating to fuel-conversion systems which can be constructed with the help of advanced chemical materials such as carbon fiber. Ammonium nitrate, a common fertilizer component has the potential of showing

NOBEL PRIZE IN CHEMISTRY 2020



(Art by Gaurav J. Dutta, 3rd Semester)

The Nobel Prize is regarded as the most prestigious awards given for intellectual achievement in the world are awarded annually from a fund bequeathed for that purpose by the Swedish inventor and industrialist Alfred Nobel.

This award is announced every year for excellence in Physics, Chemistry, Medicine, Literature, Economics, and a distinguished achievement towards humanity—commonly known as the Nobel Peace Prize.

Emmanuelle Charpentier of France and Jennifer A Doudna of the USA have been awarded the 2020 Nobel Prize in Chemistry for developing CRISPR/Cas9 genetic scissors, one of gene technology's sharpest tools. It is for the first time a Nobel Science Prize has gone to a women-only team.

The CRISPR/Cas9 genetic scissors or tools can be used to change the deoxyribonucleic acid (DNA) of animals, plants and microorganisms with extremely high precision. This technology has had a revolutionary impact on the life sciences, is contributing to new cancer therapies, and might help to cure genetic diseases. Using the CRISPR/Cas9 genetic scissors, it is now possible to change the code of life easily.

Emmanuelle Charpentier studied *Streptococcus pyogenes* when she discovered a previously

Dulen Chamuah
5th Semester

unknown molecule, *tracrRNA*. Her work showed that *tracrRNA* is a part of bacteria's ancient immune system, CRISPR refers to repetitive DNA sequences, called "clustered regularly interspaced short palindromic repeats". There are also special genes that are called "CRISPR-associated", or "Cas". They encode Cas proteins, which can disarm viruses by cleaving their DNA. The CRISPR system in *S. Pyogenes* only requires a single Cas protein, Cas9, to cleave virus DNA. Charpentier published her discovery of *tracrRNA* in 2011.

The same year, she initiated a collaboration with Jennifer A Doudna. Together, they succeeded in recreating the bacteria's genetic scissors in a test tube and simplifying the scissors' molecular components so they are easier to use. They fused *tracrRNA* and CRISPR-RNA into a single molecule, which they named guide RNA. With this guide RNA, the scissors can be controlled so that they can cut any DNA molecule at a predetermined site. Where the DNA is cut, it is then easy to rewrite the code of life using the cell's natural systems for DNA repair. Since Charpentier and Doudna discovered the CRISPR/Cas9 genetic scissors in 2012, their use has exploded. This tool has contributed to many important discoveries in basic research and medicine.



FACTS

- Many radioactive elements actually glow in the dark.
- Helium balloons float because helium is lighter than air.
- Although oxygen gas is colorless, the liquid and solid forms of oxygen are blue.

Chemistry is propelling space travel into the future

Subhasish Das
5th Semester

as a propellant material and some scientists are even experimenting with fission. Moreover, the

need for hybrid rocket engines which combine the best quality of both solid and liquid fuel engines and utilize a simple oxidizer like nitrous oxide for powder, this technology is more homogeneous and stable. A researcher at Clemson University announced the development of a strain of yeast that converts human urine and CO₂ into Omega-3-fatty acid, one that could be a supplement and space-made nutrition for astronaut survival. Chemists are successfully working on space travel and rocket technology.

Indian Women in Science and Technology Before Independence

A book name 'Vidushi : The Indian Women in Science and Technology' was published way back, by NCSM. The book contains the information and history about the Indian women in the field of Science and Technology. Some of the Indian women in this field before the Indian independence are listed below –

Kadambini (Basu) Ganguly : (18 July 1861 – 3 October 1923). She was not only the first female graduates of the British Empire, but also was the first female physicians of South Asia to be trained in western medicine. She studied medicine at the Calcutta Medical College, Calcutta and graduated in 1886.

Anna Mani : (23 August 1918 -16 August 2001). Former Deputy Director General of the Indian Meteorological Department was an Indian physicist and meteorologist. She studied at Imperial College London and after returning



Kadambini Ganguly



Anna Mani

to India in 1948, joined the Meteorological Department in Pune. She researched and published numerous papers on solar radiation, ozone and wind energy measurements. She authored two books, 'The Handbook for Solar Radiation Data for India' in 1980 and 'Solar Radiation over India' in 1981. She won the K.R. Ramanathan medal in 1987.

Priyanka Haloi
5th Semester

FACTS

- If you mix half a liter of alcohol and half a liter of water, the total volume of the liquid will be less than one liter.
- There is about 0.4 pound or 200 grams of salt (NaCl) in the average adult human body.
- A pure element takes many forms. For example, diamond and graphite both are forms of pure carbon.

Chemical hormones in human body

Hormones are the chemical substances produced in trace amount by endocrine gland that send messages to various parts of the body. They are classified as *peptide hormones* and *steroid hormones*. Hormones play a huge role in normal functioning of our body. They control heart rate, sleep cycles, sexual function and reproduction. Our metabolism, appetite, growth and development, mood, stress, body temperature are all affected by hormones.

The effects of hormones depend upon how they are released. Hence signalling effects can be classified as-

Autocrine - hormone act in the cell that secreted it.

Paracrine - hormone act on the nearby cell.

Intracrine - hormone is produced in the cell and acts intracellularly.

Endocrine - hormone act on the target cell once it is released from the respective glands.

Disease caused due to hormonal imbalance are – *diabetes, hyperthyroidism, Cushing's disease, Addison's disease etc*

Different hormones acting on our body:

• **Growth Hormone (GH)** – Over secretion of GH stimulates abnormal growth of the body leading to gigantism and low secretion results in stunted growth.

• **Adrenocorticotrophic Hormone (ACTH)** – Stimulates the synthesis and secretion of steroid hormones.

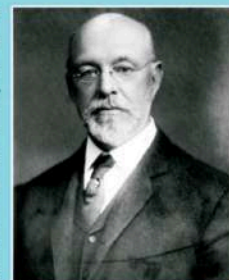
• **Thyroid Stimulating Hormone (TSH)** -Stimulates the synthesis and secretion of thyroid hormone.

• **Oxytocin** – It acts on the smooth muscle of our body and stimulates a vigorous contraction of uterus at the time of child birth and milk ejection from the mammary gland.

• **Dopamine** – It is a neurotransmitter that produces positive chronotropic and inotropic effects on the myocardium, resulting in increased heart rate and cardiac contraction. It spikes when we experience something pleasurable. It is often called as '*Happy Hormones*'

Chemistry brings you Sweetness

Ira Remsem was an American scientist known for the discovery of saccharine. Saccharine is an artificial sweetener or a non nutritive sweetner. It is a crystalline compound having no relation with carbohydrates.


 Ira Remsem
(1846-1927)

Saccharine is several hundred times sweeter than sucrose and it is used as a calorie free sweetner. The molecular formula and structure of saccharine is $C_7H_5NO_3S$. The IUPAC name of saccharine is 1,1-dioxo-1,2-benzothiazol-3-one.



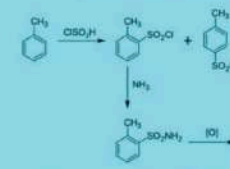
Structure of Saccharine

It has a bitter or metallic taste on high concentration.

Uses

It is used in sugar free products and is considered safe for diabetic people in limited composition. It is used as a sweetener in drinks, medicines, toothpaste, candies, etc.

Preparation of saccharine:



It is prepared by the chloro-sulphonation of toluene. Then, the subsequent treatment with ammonia (NH_3) to form o-toluenesulphonamide. By the oxidation of o-TSA, we can produce saccharine using $KMnO_4$ as an oxidising agent.

Chayanika Kalita
5th Semester

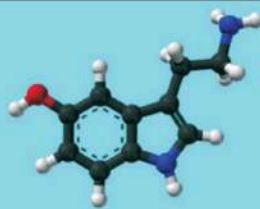
• **Seretonin** – It enables the brain cells and nervous system cells to communicate with each other. It is the key hormone that stabilizes our mood, feelings of well-being and happiness.

• **Melatonin** – It plays a very important role in the regulation of a 24 hour (diurnal) rhythm of our body. For example – it maintain the rhythm of sleep – wake cycle, body temperature. It also influence metabolism, pigmentation and defence capability.

■ **Mrigakshy Chakravarty**
3rd Semester



Dopamine



Seretonin



Melatonin

Application of nanotechnology in drug delivery

Nanotechnology drug delivery is used for infection treatment in light of increasing strains of drug resistant bacteria though the enhanced permeability and retention effect is predominantly in cancer treatments and it is similar with pathophysiology pathways and could be utilised for infection treatment.

Although the retention effect in cancer tumours is due to the lack of a functioning lymphatic system, it is found in clearance of small molecules during infection treatment. Infect Dysfunctional lymphatic drainage is a characteristic of infections. Nanoantibiotics will utilise this effect to enhance infection treatment via the application of both nanoparticles with antimicrobial therapies and nanosized biological molecules for improved antibiotic drug delivery.

A large majority of cardiovascular nanomedicine research has focused on fabricating

nanoparticles for improved targeting as a means to overcome biological barriers. Nanotechnology is advanced to deliver drug treatment for heart disease, targeted drug delivery to diseased in heart tissue can occur because inflammatory changes also produce increased vascular permeability and retention of nano-scale molecules. Coronary artery disease is the progressive plaque formation on the major arteries that can lead to heart failure. Nanomedicine can be utilised as a valid treatment because development of disease occurs at the cellular level. Nanotechnology could produce targeted delivery of statins to the site of need and therefore reduce toxicity to other cells.

Source:-
Application of nanotechnology
www.science direct.com
Application of nanotechnology
www.researchnet.com
Nanotechnology Drug Delivery for infection treatment and Heart disease
www.azonano.com

Suresh Kumar Sah
5th Semester



Photo: "Lab Cleanliness Drive" Event
Dated 30th October, 2021

FACTS

- One bucket full of water contains more atoms than there are buckets of water in the Atlantic ocean.
- The rarest naturally occurring element in the Earth's crust may be astatine. The entire crust appears to contain about 28 grams of the element.
- The human body contains enough carbon to provide "lead" (which is really graphite) for 9000 pencils.

THE CHEMISTRY OF SUNSCREEN

Summer sun brings with it the risk of sunburn, so we'll all be slapping on the sunscreen to guard against it. But what are the chemicals that keep you from turning as red as a lobster? This graphic looks at them and how they work.



TYPES OF UV RADIATION

UVA 320-400nm
wavelength

Accounts for 95% of solar UV radiation reaching Earth's surface. Penetrates deepest into skin, and contributes to skin cancer via indirect DNA damage.

UVB 290-320nm
wavelength

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.

UVC 290-100nm
wavelength

Filtered out by ozone in the Earth's atmosphere, and as a result does not reach the surface of the Earth, and doesn't cause skin damage.

17

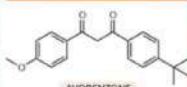
SUNSCREEN ACTIVE INGREDIENTS APPROVED IN THE USA

28

SUNSCREEN ACTIVE INGREDIENTS APPROVED IN THE EU

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 radiation, with the chemical structure affecting whether they absorb UVA, UVB, or both. Several different chemicals are used in sunscreen to ensure full protection.

UVA BLOCKERS



Let's talk SCIENCE

Do you enjoy talking about science and sharing knowledge with people? Then, you need to pay attention to the term "Science Communication". Science communication is the practice of informing, educating, raising awareness of science-related topics among people. It talks about scientific discoveries and arguments for the awareness of common people.

The National Academies of Sciences, Engineering, and Medicine lays the five general goals for science communication as (i) sharing recent findings and excitement for science, (ii) increasing public appreciation of science, (iii) increasing knowledge and understanding of science, (iv) influencing the opinions, policy preferences or behavior of people, and (v) ensuring that a diversity of perspectives about science held by different groups are considered when solutions to societal problems are pursued.

Science communication is not a new field, people love sharing new stuff about science. You may have seen different



people on social media sharing their scientific journey and new discoveries, these are also a part of science communication. And, this

newsletter is also a part of science communication!

Radhika Mishra
5th Semester

Air Quality Index

Suresh Kumar Sah | 5th Semester

Air Quality Index is an index for reporting air quality on a daily basis. It is a measure of how air pollution affects health within a short period of time. The purpose of AQI is to help people know how air quality impacts their health.

The concept of AQI has been widely used by many developed countries. In India, AQI is monitored by the Pollution control board or Environmental protection agency and it calculates based on the average concentration of particular pollutants measured over a standard time interval such as 1hrs, 8hrs, and 24hrs or Air quality is determined physically by knowing air pollutants concentration. The Environmental Protection Agency(EPA)

calculates AQI for Five major air pollutants for which national air quality standards have been established to safeguard public health.

- a) Ground-level Ozone
- b) Particle pollutants (PM_{2.5}/PM₁₀)
- c) Carbon Monoxide
- d) Sulphur Dioxide
- e) Nitrogen Dioxide.

The higher the AQI value the greater the level of air pollution and the greater the health concerns. As per reports, presently, Delhi has the worst AQI all over the world. Here, is the graph regarding AQI recorded of different places around the world for over some days.

As per WHO, air pollution kills 600,000 children per year globally. Air pollution in India is responsible for 30 percent of premature

deaths, cancer, and mental diseases a report by the Centre for Science and Environment found that. In Delhi, India sometimes, the situation gets so worse that educational institutes are shut for weeks. Such rising AQI is harmful to people of all ages, it cuts down the age of people.

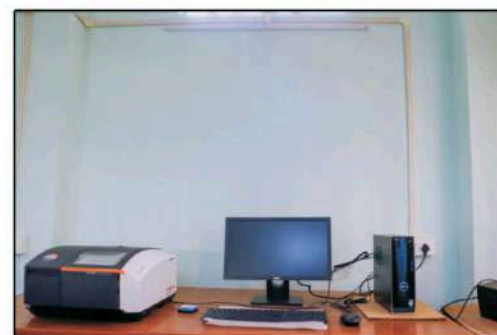
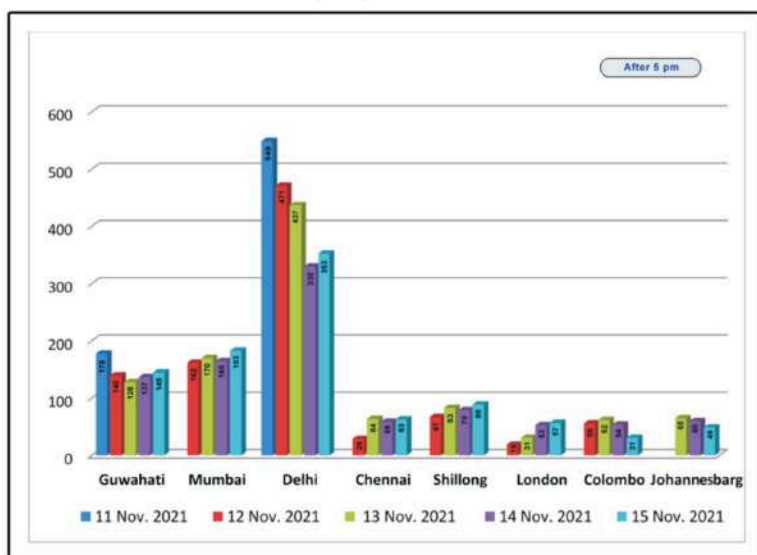


Photo: UV-Visible Spectrophotometer



Photo: Departmental Research Laboratory



Photo: General Laboratory

দুহিতা ...a column dedicated to woman achievers in the field of science and technology



ড° জুবিলী পুৰকায়স্থ

২০২১ চনত ক'ভিড-১৯ প্ৰতিৰোধী ঔষধ, 'ডি আৰ ডি অ'-২ ডি'ক্লি থুক'জ ' চমুকৈ ২ ডিজিৰ প্ৰস্তুতকাৰী বিজ্ঞানীৰ দলটোৰ অন্যতম সদস্য। ড° জুবিলী পুৰকায়স্থৰ জন্ম হৈছিল ১৯৭৯ চনত অসমৰ কৰিমগঞ্জ জিলাৰ মহিাসান নামৰ এখন সৰু গাঁৱত। তেখেতৰ পিতৃৰ নাম 'সুদৰ্শন পুৰকায়স্থ আৰু মাতৃ বিনয় কুমাৰী পুৰকায়স্থ। অতি দৰিদ্ৰ পৰিয়ালত জন্মগ্ৰহণ কৰা জুবিলীয়ে জীৱনত সফল হ'বলৈ বহুতো যাত-প্ৰতিযাতৰ সন্মুখীন হ'বলগীয়া হৈছিল।

ড° জুবিলী পুৰকায়স্থই শিক্ষা জীৱনৰ পাতনি মেলিছিল ৪৪ নং মহিাসান প্ৰাথমিক বিদ্যালয়ত। পৰৱৰ্তী সময়ত তেখেতে পাতু উচ্চতৰ মাধ্যমিক বিদ্যালয়ৰ পৰা প্ৰবেশিকা পৰীক্ষাত উত্তীৰ্ণ হয়। তাৰপিছত তেখেতে কৰিমগঞ্জ মহাবিদ্যালয়ত বিজ্ঞান শাখাত নামভৰ্তি কৰে আৰু তাৰ পৰাই স্নাতক ডিগ্ৰী লাভ কৰে। ইয়াৰ পৰৱৰ্তী সময়ত তেখেতে যোৰহাটৰ উত্তৰ-পূব বিজ্ঞান আৰু প্ৰযুক্তি প্ৰতিষ্ঠানৰ পৰা উচ্চশিক্ষা গ্ৰহণ কৰাৰ লগতে ডক্টৰেট ডিগ্ৰীও অৰ্জন কৰে।

২০০৮ চনত ড° পুৰকায়স্থই তেজপুৰস্থিত ডি আৰ ডি অ'ৰ প্ৰতিৰক্ষা গৱেষণাগাৰত বিজ্ঞানী হিচাপে যোগান কৰি কৰ্মজীৱনৰ পাতনি মেলে। প্ৰায় ছয়টা বছৰ এই প্ৰতিষ্ঠানৰ লগত জড়িত

থাকি ২০১৪ চনত তেখেতে নতুন দিল্লীলৈ বাওনা হয় আৰু বৰ্তমান তেখেত নতুন দিল্লীত থকা ডি আৰ ডি অ'ৰ অধীনস্থ ইনষ্টিটিউট অৱ নিউক্লিয়াৰ মেডিচিন আৰু এলাইড ছায়েন্সেছ (INMAS) ৰ এগৰাকী বিজ্ঞানী হিচাপে কৰ্মৰত হৈ আছে। তেওঁ ২৫ খনতকৈ অধিক গৱেষণা পত্ৰ প্ৰকাশ কৰিছে। ইয়াৰ লগতে তেওঁৰ পেটেণ্ট আছে আৰু কিতাপো লিখিছে। International Agency for standards and Ratings এ ড° পুৰকায়স্থক World Academic Champion -2018 ৰ সন্মান দিয়ে।

ক'ভিড-১৯ ৰ সংক্ৰমণ প্ৰতিহত কৰিবলৈ ভাৰতৰ কেন্দ্ৰীয় প্ৰতিৰক্ষা মন্ত্ৰালয়ৰ অধীনস্থ প্ৰতিৰক্ষা গৱেষণা আৰু বিকাশ সংগঠন চমুকৈ ডি আৰ ডি অ' য়ে ২০২১ চনত 'ডি আৰ ডি অ'-২ ডি'ক্লি থুক'জ ' চমুকৈ '২ ডিজি' নামৰ এবিধ বিশেষ ঔষধ প্ৰস্তুত কৰি উলিয়ায়। ডি আৰ ডি অ'ৰ অধীনস্থ ইনষ্টিটিউট অৱ নিউক্লিয়াৰ মেডিচিন আৰু এলাইড ছায়েন্সেছৰ একাধিক চিকিৎসক আৰু বিজ্ঞানী উক্ত প্ৰকল্পৰ লগত জড়িত হৈছিল আৰু বিজ্ঞানীদলটোৰ লগত ড° পুৰকায়স্থই দেশৰ বাবে আগবঢ়োৱা অনবদ্য অৱদানৰ বাবে আমি অসমবাসী গৌৰৱান্বিত।

Dipumoni Thakuria
5th Semester



Photo: 4th Volume of BOSON

Editor's Message

It's quite a thrill to be the editor of the 5th volume of Boson, the annual newsletter of the Chemistry department of Pragjyotish College. What I loved about this newsletter was the participation from all the students of the Chemistry Department, without their help this newsletter would not be a real thing. We have put our best in making this newsletter worth reading by including topics from different corners of chemistry.

I truly hope these articles motivate you to know more about chemistry, its significance, and you share them with your circle. As you are reading this, our efforts are getting paid with infinite ROI.

Regards,
Radhika Mishra

Published on 30th November 2020

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