



Delhi Public School Bangalore East

SCIENTIA

VOLUME 3

2024



Delhi Public School



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CHAIRMAN - KKECT



Message From Sri. K. Rahman Khan

*Former Member of
Parliament (Rajya Sabha)
Chairman - KKECT
Pro Vice-Chairman – DPS
Bangalore/Mysore*

"Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution." – Albert Einstein."

True progress arises when we blend knowledge with foresight and pragmatism. This powerful combination can yield extraordinary outcomes. I firmly believe that our children should be immersed in a rich tapestry of social, cultural, literary, educational, artistic, and scientific endeavors. As we celebrate the release of another e-edition of Scientia, I extend my heartfelt compliments to the faculty, our brilliant students, and convey my best wishes to the editorial team and the entire family of DPS Bangalore East

SECRETARY - KKECT



Message From Mr. Maqsood Ali Khan

*Secretary – KKECT
Member Board of
Management
DPS Bangalore/Mysore*

"Science is a way of thinking much more than it is a body of knowledge." – Carl Sagan

Scientific inquiry is fueled by human experiences and observations, guided by societal needs and challenges, and empowered by science literacy, which equips individuals to think critically and make knowledge based decisions. The mind, a remarkable entity, unites thoughts, limitless imagination, and perception into a powerful force. With this perspective, I warmly congratulate the Principal, the entire science faculty, and the editorial team for bringing forth another outstanding e-edition of Scientia. This unique platform continues to nurture and showcase the creativity and curiosity of our talented students.

TREASURER - KKECT



Message From Mr. Mansoor Ali Khan

*Treasurer – KKECT
Member Board of
Management
DPS Bangalore/Mysore*

"Success is stumbling from failure to failure with no loss of enthusiasm." – Winston Churchill

Innovations and discoveries in Science have led to countless improvements in healthcare, technology, and daily life. Science fuels technological advancements, enabling us to develop new solutions and products. The main essence of this platform has been to promote interest in science and research and stimulate scientific curiosity among children by overcoming the barriers and stereotypes about the inaccessibility of scientific knowledge. Congratulations to the entire editorial team of Scientia on their dedication to sharing knowledge and sparking innovation through this e-edition of Scientia. This magazine is a indispensable resource for science enthusiast.



Message From The Principal

Mrs. Manila Carvalho

"Science is the poetry of reality." - Richard Dawkins

It is with great pride and enthusiasm that I present to you the latest edition of our science magazine, Scientia. Science, as we know, is the pursuit of knowledge and understanding of the natural world. It empowers us to question, explore, and innovate, leading to discoveries that shape our future. In the pages of Scientia, you will find not only a celebration of scientific thought but also an exemplification of the creativity and intellectual curiosity that our school fosters.

I would like to take this opportunity to commend our remarkable students and dedicated faculty whose passion for science is reflected in every article and illustration. My heartfelt gratitude extends to the Management for their continuous support and commitment to providing a nurturing environment where academic excellence can thrive.

A special note of appreciation goes to the editorial team, whose hard work and meticulous attention to detail have brought this publication to life. Scientia stands as a shining example of what can be achieved when knowledge, collaboration, and perseverance come together.

I encourage each of you to delve into this magazine with curiosity and wonder. May Scientia inspire you to explore the world of science with an open mind and a relentless drive to learn.

Happy reading!



Message From The Vice-Principal

Mrs. Priti Ssoota

"The important thing is to never stop questioning." — Albert Einstein

Albert Einstein's words serve as a powerful reminder of the essence of science—an endless journey of curiosity and questioning. Science is not just about finding answers but about constantly seeking to understand the world in deeper, more meaningful ways.

At Delhi Public School Bangalore East, we are dedicated to fostering this spirit of inquiry in every student. Whether through hands-on experiments, thought-provoking discussions, or groundbreaking research, we encourage each student to maintain their inquisitiveness, no matter how small or seemingly insignificant. Each question they pose brings us one step closer to new discoveries and innovations.

I am immensely proud of the achievements showcased in this publication. They reflect the hard work, passion, and relentless curiosity of both our students and teachers. As you read through these pages, I hope you are inspired to continue exploring, questioning, and challenging the status quo. Remember, it is through our questions that we grow, learn, and ultimately, change the world.

I extend my sincere gratitude to the Management and the Principal for their unwavering encouragement and support, which have been instrumental in 'Scientia' being a successful publication. My heartfelt congratulations to the esteemed faculty and the diligent editorial team. Wishing you all an enlightening and enjoyable reading experience!

HEAD OF DEPARTMENT



Mrs. Anjali Kumar

Head of Department of
Biology

‘The science of today is the technology of tomorrow ’

Science is not just a subject but a way of understanding the world around us. Our aim is to foster a spirit of enquiry and curiosity amongst students. The publication serves as a platform to showcase their innovative ideas, research and experiments. I am proud of the dedication and hard work that has gone into each article and I believe it reflects the high standards of scientific exploration that our department upholds.

I would like to extend my gratitude to all the contributors, editors and supporters who made this publication possible.

HEAD OF DEPARTMENT



Mrs. S Aparna Raju

Head of Department of
Physics

"Unlocking Curiosity Beyond the Classroom"

DPS Bangalore East and the Department of Science are proud to present the 3rd edition of SCIENTIA, our annual publication.

Within these pages, discover the vibrant scientific spirit of our students, nurtured by dedicated teachers. This year's edition showcases innovative ideas, creative projects, and thought-provoking articles that highlight our commitment to holistic education.

SCIENTIA embodies our mission to inspire curiosity, foster critical thinking, and create a lasting impact on society. Join us in celebrating the scientific zeal of our talented students.

Read, explore, and be inspired!

HEAD OF DEPARTMENT



Mrs. Shweta Gupta
Head of Department of
Chemistry

"Curiosity fuels discovery."

Ever since the dawn of civilization, human beings have been on a quest for knowledge. This incredible journey that we have embarked upon would not be possible without exploration and research. Science greatly influences our daily lives.

Science is the study of matter, the very basis of our existence, and the behavior of matter. Scientific research would not be nearly as advanced as it is today, if it weren't for the distinguished, curious thinkers of the past who had put forth assiduous collaborative effort. It is now in our hands to follow the footsteps and to build upon the work of the greatest scientists.

The Department of Science of Delhi Public School Bangalore East is pleased to present the 3rd edition of SCIENTIA our annual e-magazine, a publication dedicated to fostering scientific exploration, innovation, and knowledge sharing. Our mission is to provide a platform that highlights groundbreaking research, creative ideas, and thought-provoking perspectives from experts and enthusiasts in the scientific community.

In this regard, we have curated a diverse collection of articles that span multiple disciplines, offering readers fresh insights into the ever-evolving world of science. From the latest technological advancements to explorations of environmental challenges, we aim to inspire curiosity, ignite discussions, and broaden understanding.

EDITORIAL TEAM



As another year unfolds, we're thrilled to welcome you to the 3rd Edition of Scientia—your portal to the wonders and mysteries of science! This issue journeys through fascinating realms, from the mind-bending questions of the Fermi Paradox to the precision of DNA fingerprinting. Each article is crafted to spark curiosity and expand your horizons in the vast world of science.

For this edition, we've amped up the visuals to make your reading experience as dynamic as the content itself! From bold infographics to vivid illustrations, each page is designed to captivate and draw you deeper into the stories behind the science. We wanted every article to feel like a visual journey, adding excitement and a splash of color to the learning process.

Thank you for your continued support, and we hope this edition inspires and fuels your passion for the fascinating world of science. We loved working on this year's issue and hope you enjoy every bit of it as much as we enjoyed creating it.

Happy Reading, and let the exploration begin!

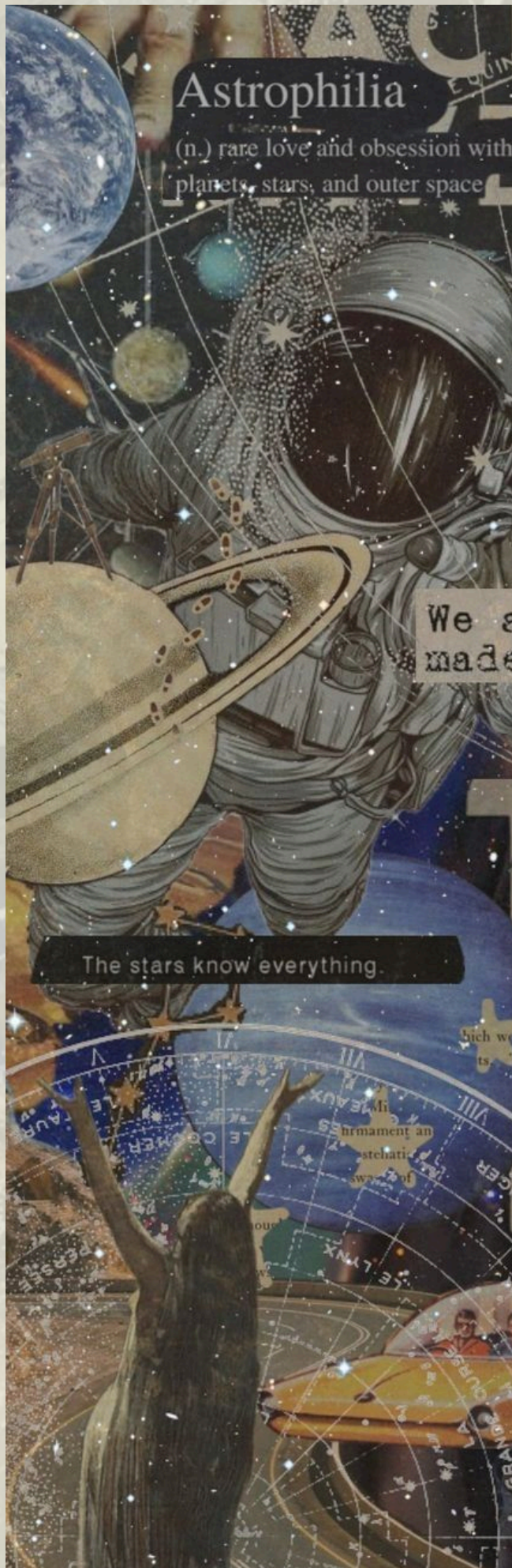
Aanyaa Agrawal - 12 O

Anika Gupta - 12P

Mayur Somaiah - 12 Q

COSMOS





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"To the Stars"

THE PHYSICS BEHIND THE TSAR BOMBA

-SARVESH IYER
12L

ORIGINS

On October 30, 1961, the world witnessed the detonation of Tsar Bomba, the most powerful nuclear bomb ever exploded. It was developed by the Soviet Union during the Cold War, a period marked by intense nuclear arms competition between the superpowers. With a mind boggling yield of approximately 50 megatons of TNT, this Soviet-era weapon remains unparalleled in its explosive force.

ITS STRUCTURE

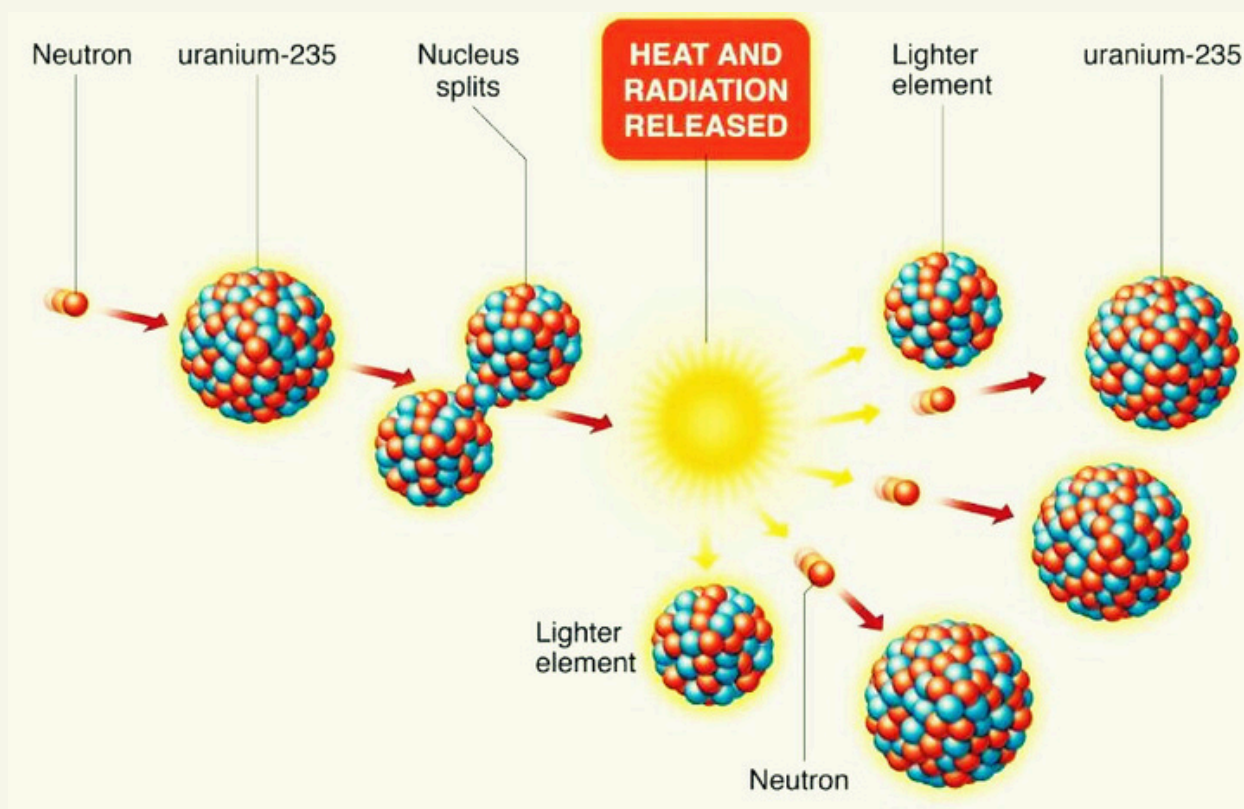
CORE: At its core, the bomb utilized a fission bomb, similar to those used in earlier atomic weapons. This primary stage relied on nuclear fission, where heavy atomic nuclei such as Uranium-235 or Plutonium-239 split into smaller nuclei, releasing a massive amount of energy and initiating a chain reaction.

SECONDARY LAYER: Surrounding the primary stage was a fusion stage. This part contained fusion fuel, typically isotopes of hydrogen like deuterium & tritium. The fusion process involved combining these light atomic nuclei to form heavier nuclei, releasing even more energy.



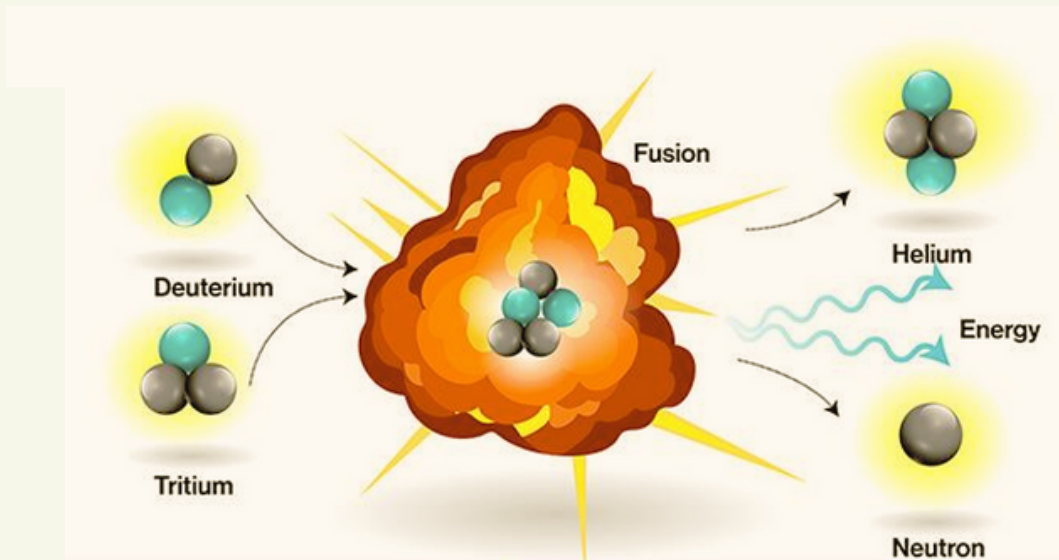
HOW IT WORKS

The fission reaction in the primary stage produced extreme temperatures and pressures, which in turn compressed the fusion fuel in the secondary stage. The fusion reaction, driven by these conditions, released a tremendous amount of additional energy. The combined effects of these reactions resulted in a yield equivalent to 50 million tons of TNT, far surpassing any previous weapon in terms of power. The explosion created a fireball with a radius of about 4.6 kilometers and a mushroom cloud that ascended to an altitude of 64 kilometers. The shockwave from the explosion was felt up to 900 kilometers away, while the intense thermal radiation caused severe burns at distances of up to 100 kilometers from ground zero.



FISSION STAGE: Fission is the process where heavy atomic nuclei, such as Uranium-235 or Plutonium-239, split into smaller nuclei when struck by a neutron. This splitting releases a significant amount of energy and additional neutrons, which can then cause more nuclei to split in a chain reaction. This chain reaction generates a massive explosion and is used in the primary stage of nuclear bombs to produce the initial burst of energy.

FUSION STAGE: Fusion involves combining light atomic nuclei, such as isotopes of hydrogen (deuterium and tritium), to form a heavier nucleus. This process requires extremely high temperatures and pressures to overcome the repulsion between positively charged nuclei. Fusion releases even more energy than fission and occurs in the secondary stage of thermonuclear bombs, triggered by the energy from the fission reaction.



**J. Robert Oppenheimer
really meant what he
said.**

CONCLUSION

The bomb had the potential to be so powerful that, although its initial design had a potential yield of 100 megatons, it was scaled down to 50 megatons to mitigate radioactive fallout and ensure the safety of the test aircraft.

Reflecting on the sheer magnitude of such power, it brings to mind a famous quote from the film Oppenheimer:

"When I came to you with those calculations, we thought we might start a chain reaction that would destroy the world."

"What of it?"

"I believe we did."

02 FLASH!!!!

- PRATYUSHA PAL
12Q

The particle accelerator at S.T.A.R. Labs, a fictional facility in Central City, is designed to study and manipulate subatomic particles. During an experiment, the accelerator explodes, releasing a burst of dark matter energy. Barry Allen is exposed to the energy from the explosion while in the vicinity. This exposure causes a chemical reaction in his body, resulting in the development of super-speed abilities. We all know this introductional story; but do you all know how the show uses the scientific concept of PARTICLE ACCELERATORS to explain his powers. Further details await as you read on!!!

A particle accelerator is a sophisticated scientific instrument used to accelerate charged particles, such as electrons, protons, or ions, to extremely high speeds and energies. The core principle behind a particle accelerator is to harness electromagnetic fields to propel particles along a predetermined path, often within a vacuum chamber to minimize interference from air molecules.

This process enables researchers to probe the fundamental components of matter and explore the underlying forces of nature.



Particle accelerators come in various types, each serving specific research needs. Linear accelerators, or linacs, accelerate particles along a straight line. By repeatedly passing particles through an alternating electric field, these accelerators achieve high velocities. On the other hand, circular accelerators, such as cyclotrons and synchrotrons, use magnetic fields to keep particles on a circular path, allowing them to gain energy with each pass through an accelerating region.

One of the most renowned examples of a particle accelerator is the Large Hadron Collider (LHC) at CERN (the European Organization for Nuclear Research). The LHC is a massive circular accelerator with a circumference of about 27 kilometers, situated underground on the border between Switzerland and France. It collides protons at near-light speeds, enabling scientists to observe and analyze fundamental particles and forces. The LHC has been instrumental in the discovery of the Higgs boson, a particle crucial to understanding the mechanism that gives mass to other elementary particles.



The construction and operation of particle accelerators involve cutting edge technology and precision engineering. Superconducting magnets are used to generate powerful magnetic fields necessary to steer and focus the particle beams. These magnets must be cooled to cryogenic temperatures using liquid helium to maintain their superconducting state.

In medicine, accelerators are used in radiation therapy for cancer treatment, where they deliver targeted doses of radiation to destroy cancer cells while minimizing damage to surrounding healthy tissues. Accelerators also play a role in industrial applications, such as material analysis and quality control, by generating high-energy X-rays for inspecting the integrity of structures and components.

The study of particle accelerators has significantly advanced our understanding of the universe. By probing the smallest scales of matter and energy, scientists can test theories of fundamental physics and explore new phenomena. The quest for knowledge in particle physics continues to drive the development of more powerful and sophisticated accelerators, pushing the boundaries of what we know about the universe and its origins.

In summary, particle accelerators are pivotal tools in modern science and technology. They enable scientists to explore the fundamental building blocks of matter, test theories of physics, and develop new applications with wide-ranging impacts. The continued advancement of accelerator technology promises to unlock even more secrets of the universe, offering insights that could reshape our understanding of the physical world.

BOSE - EINSTEIN CONDENSATE

- SHIVANGI M (11P)
ANANYA A (11R)

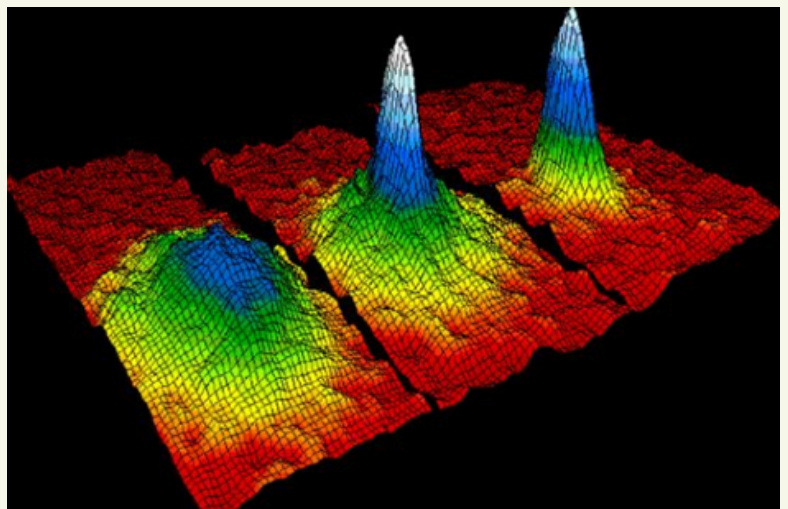


Imagine a party where everyone is dancing, and then suddenly the temperature drops too low, and we all huddle together to keep warm. This is kind of like what happens in a Bose-Einstein Condensate (BEC)! As we cool the gas of atoms, we lower its momentum and each particles' wave nature starts becoming more and more pronounced and when cold enough the wavelength becomes so long that these atoms really start blending into each other creating a MEGA atom! It's a queer form of matter where really cold atoms act like one very huge "super atom". When atoms

are super cold, they start behaving like a single unit instead of individual particles. This super dense gas is about 200,000 times less dense than air!

METHODS OF COOLING DOWN THE ATOMS

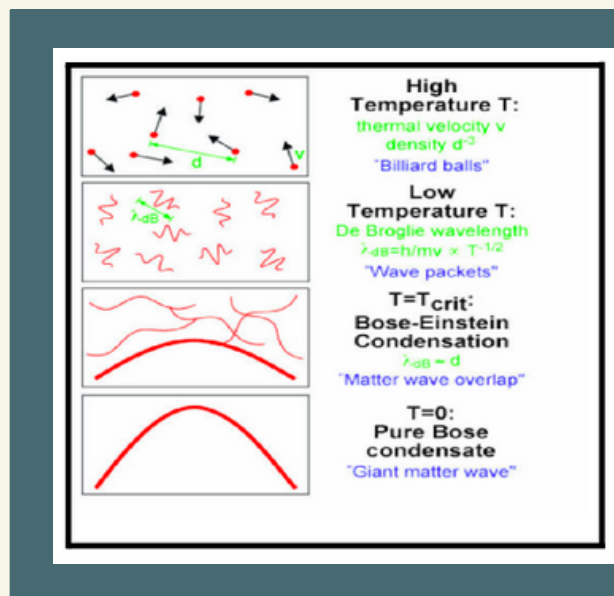
1. Laser cooling
2. Evaporative cooling
3. Magnetic trap



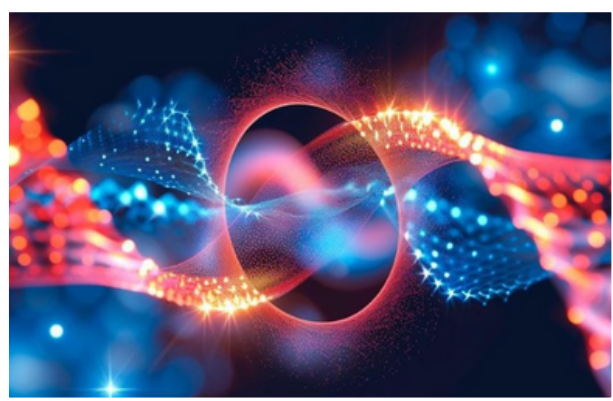
HOW DO LASERS WORK TOWARDS COOLING DOWN THE ATOMS

In the 1980s, scientists discovered a fascinating way to cool atoms using lasers. By tuning a laser to a particular resonance frequency scientists can slow down the motion of an atom which frequently cools it.

It's kind of like when you hear the sound of a passing car change pitch as it approaches and then moves away. By adjusting the laser's frequency, it's almost like giving the atoms a little nudge, causing them to slow down. They used a special kind of laser to give atoms a little push and slow them down, somewhat like applying brakes to a car. By using a coordinated system of multiple lasers, they were able to cool the atoms extensively, creating what they called "optical molasses." This cooling process allowed the atoms to reach extremely low temperatures, which is important for creating a "Bose-Einstein Condensate."



EVAPORATIVE AND COOLING MAGNETIC TRAP

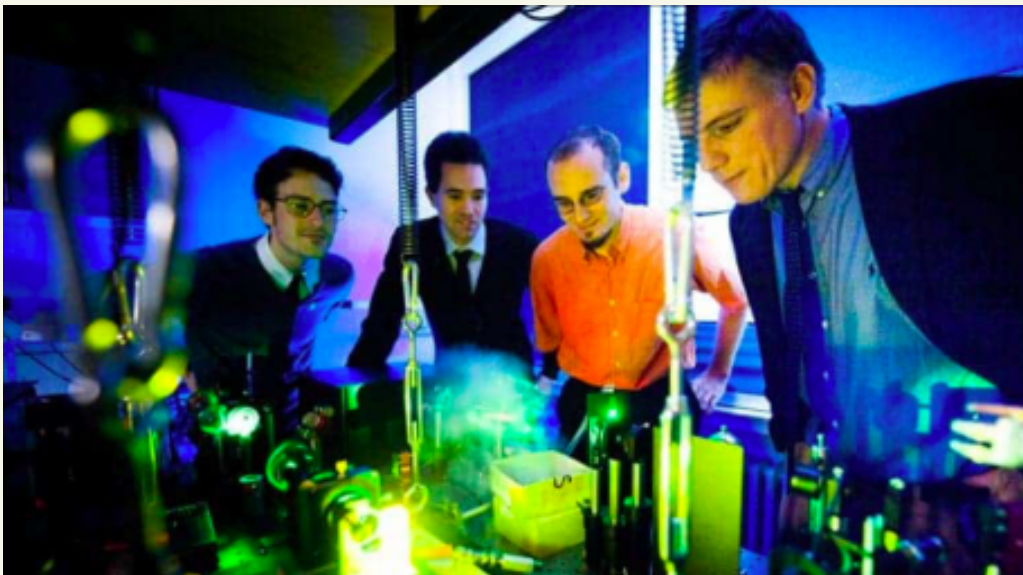


Bose-Einstein Condensate (BEC), scientists first use lasers to cool down atoms so they move slower. Then they trap the cooled atoms using a magnetic field to keep them from warming up. After that, they use a method called evaporative cooling to remove the fast-moving atoms, allowing the remaining ones to cool even further. This whole process is adjusted carefully to reach

really, really cold temperatures just above absolute zero. When the atoms get to these super cold temperatures, they act like a single group instead of individual atoms

APPLICATIONS OF BOSE EINSTEIN CONDENSATE

- Quantum computing: BECs are a path to explore quantum computing because they can exhibit quantum behaviors on a macroscopic (large) scale. This helps researchers understand how to build more stable quantum computers.
- Environmental Monitoring: Bose-Einstein Condensates (BECs) are highly sensitive to environmental changes, making them excellent for creating sensors that detect small earth movements and unusual air events. They are used as biosensors for environmental monitoring.



- Navigation System: BECs are great for precise navigation due to their ability to measure gravitational variations accurately. They can provide location data in environments where GPS is unreliable, such as underground or deep-sea explorations.

CONCLUSION

In short, Bose-Einstein Condensates are like the cool, peculiar bridge between classical and quantum worlds. They not only strengthen our understanding of physics but also promise some seriously exciting technological quantum leap! Who knows what cosmic secrets BECs will unfold in the future?



The Fermi Paradox: Theories on the Absence of Extraterrestrial Contact

~ SONIA BASRANI
XIM

INTRODUCTION

The Fermi Paradox encapsulates one of the most profound questions in modern science: Given the vastness of the universe and the high probability of extraterrestrial life, why have we not yet encountered any evidence of such civilizations? Despite the immense number of stars and potentially habitable planets, the silence from the cosmos persists, leading to a paradox that continues to intrigue scientists, philosophers, and the general public. This paper explores various theories proposed to resolve the Fermi Paradox, each offering a unique perspective on why we might be alone—or why we might not be able to detect others.

THE GREAT FILTER: A COSMIC BOTTLECK

THE THEORY

The Great Filter theory suggests that at some stage in cosmic evolution, there is a significant barrier that prevents life from reaching a stage where it can colonize galaxies or communicate across interstellar distances. This filter could exist before the emergence of life, during the transition from simple to complex organisms, or at the level of advanced civilizations.

IMPLICATIONS

The Great Filter theory suggests that at some stage in cosmic evolution, there is a significant barrier that prevents life from reaching a stage where it can colonize galaxies or communicate across interstellar distances. This filter could exist before the emergence of life, during the transition from simple to complex organisms, or at the level of advanced civilizations.

THE RARE EARTH HYPOTHESIS: UNIQUENESS OF THE EARTH

THE THEORY

The Rare Earth Hypothesis posits that the conditions necessary for complex life are extremely rare. While microbial life might be widespread, the specific combination of factors that allowed for the development of complex, multicellular life on Earth—such as a stable climate, a large moon, and the presence of plate tectonics—might be unique.

IMPLICATIONS

According to this hypothesis, while the universe may teem with simple life forms, the emergence of intelligent, technologically advanced civilizations could be extraordinarily rare. This suggests that we might be in a particularly fortunate position, making the lack of contact with other intelligent beings less surprising.



THE ZOO HYPOTHESIS

THE THEORY

The Zoo Hypothesis proposes that advanced extraterrestrial civilizations are aware of us but intentionally avoid contact, much like zookeepers observe animals in a zoo without interfering. This scenario assumes that these civilizations are following a policy of non-interference to allow for the natural development of less advanced societies.

IMPLICATIONS

If this hypothesis is correct, our apparent isolation might be a result of an ethical or scientific decision by more advanced beings. This theory implies that the silence from the cosmos might not be due to a lack of interest but rather a deliberate choice to preserve the natural progression of civilizations like ours.



THE SELF-DESTRUCTION HYPOTHESIS: THE PERILS OF PROGRESS

THE THEORY

The Self-Destruction Hypothesis suggests that advanced civilizations might frequently self-destruct before they can establish interstellar communication or travel. This could occur through warfare, environmental destruction, or other catastrophic events that arise from the technological advancements that enable such civilizations to cause their own downfall.

IMPLICATIONS

This theory proposes that the development of advanced technology is inherently linked to existential risks. The idea that intelligent civilizations might often face self-annihilation before achieving long-term spacefaring capability could explain the absence of detectable extraterrestrial civilizations.

THE TRANSCENDENCE HYPOTHESIS

THE THEORY

The Transcendence Hypothesis posits that advanced civilizations may evolve beyond physical forms into non-biological entities, such as artificial superintelligences or beings existing in virtual realities. These post-biological entities might be beyond our current ability to detect or comprehend.

IMPLICATIONS

If this hypothesis is valid, the lack of contact could be because advanced civilizations have left the physical realm and now exist in forms that are undetectable by our current methods. This theory suggests that the search for extraterrestrial life might be limited by our own understanding of what life could become.

THE INVISIBILITY HYPOTHESIS: STEALTH AND SECRECY

THE THEORY

The Invisibility Hypothesis suggests that advanced civilizations might use technologies or strategies to avoid detection. They could employ stealth technology or communication methods that are beyond our current detection capabilities, such as advanced signal encryption or stealth technologies that mask their presence.

IMPLICATIONS

This theory implies that we might be missing signals or evidence of extraterrestrial civilizations because we are searching in the wrong ways or frequencies. The possibility that advanced beings are deliberately avoiding detection could explain why we have not yet observed any signs of extraterrestrial life.

THE PANSPERMIA HYPOTHESIS: LIFE'S COSMIC DISTRIBUTION

THE THEORY

The Panspermia Hypothesis proposes that life, or the building blocks of life, might be distributed throughout the universe via comets, meteorites, or cosmic dust. In this view, life might be widespread, but intelligent life is still rare or non-existent.

IMPLICATIONS

This hypothesis shifts the focus from the rarity of life to the rarity of intelligent life. It suggests that while the basic ingredients for life might be common, the development of complex, intelligent civilizations could be an exceedingly rare occurrence.

THE COMMUNICATION LIMITATIONS HYPOTHESIS: THE CHALLENGES OF DISTANCE

THE THEORY

The Communication Limitations Hypothesis argues that even if extraterrestrial civilizations exist, the vast distances between stars and the limitations of our technology make interstellar communication challenging. Signals might be too weak, or civilizations might use communication methods that we are unable to detect or interpret.

IMPLICATIONS

This theory emphasizes the practical difficulties of establishing contact across cosmic distances. It suggests that while extraterrestrial life might be common, the challenges inherent in long-range communication could be a significant barrier to making contact.

A hand-drawn diagram of the Drake Equation, $N = R^* \times f_p \times \eta_e \times f_l \times f_i \times f_c \times L$, with arrows pointing to each term and handwritten annotations:

- R^* : The average rate of star formation (indicated by a star symbol).
- f_p : The fraction of stars with planets.
- η_e : The fraction that can go on to support intelligent life.
- f_l : The fraction that can go on to develop life.
- f_i : The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.
- f_c : The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.
- L : Length of time such civilizations release detectable signals into space.

THE SIMULATION HYPOTHESIS: A MANUFACTURED REALITY

THE THEORY

The Simulation Hypothesis proposes that our reality might be a sophisticated computer simulation created by a more advanced civilization. In this scenario, the absence of evidence for extraterrestrial life could be a result of our simulated reality not including such entities.

IMPLICATIONS

If this theory is correct, our understanding of the universe and the search for extraterrestrial life might be limited by the parameters of the simulation. This hypothesis challenges our perceptions of reality and raises questions about the nature of existence and consciousness.

CONCLUSION

The Fermi Paradox continues to captivate and challenge our understanding of the universe. Each theory provides a unique lens through which to view the absence of detectable extraterrestrial civilizations. From the possibility of cosmic bottlenecks to the challenges of communication, these theories offer intriguing explanations for why we have yet to make contact with other intelligent beings. As our technology advances and our exploration of the cosmos continues, we may gain new insights into this profound paradox and further our understanding of our place in the universe.



Enrico Fermi estimated there should be 10,000,000,000,000,000 intelligent civilizations in the observable universe.

After millions of years of technological progress, an alien civilization should be capable of long-distance space travel.

Side Note: In less than 100 years, humans went from traveling in covered wagons to landing on the moon.

The paradoxical question Enrico asked was...



SO WHERE IS EVERYONE?

POSSIBLE SOLUTIONS TO THE FERMI PARADOX



IT'S JUST US

There are no signs of
other life.



LATE TO THE PARTY

Super-intelligent
life may have
already colonized
the galaxy.



MIDDLE OF NOWHERE

The galaxy has been
colonized.

A STUDY ON BRAIN COMPUTER INTERFACES

~ Siri R
- XI S

INTRODUCTION

Have you ever wondered how an amputee can lift their robotic arm just by thinking about it? Or how a person with locked-in syndrome can communicate by moving an arrow on a computer system with his brain? The human brain seems to connect with these machines almost like a Bluetooth device.

So, what technologies really come into play in these mechanisms? Considering the high burden of neurological diseases that are coming up, the necessity to introduce the latest technology and to develop tools and equipment showing precision is essential. Tools that commit to simplifying the complexities of neurological problems, ease of access, and are cost-effective are imperative.



BRAIN COMPUTER INTERFACES

Brain-Computer Interfaces are man-made systems that connect our most unusual apparatus, the brain, to external technologies, giving common people the ability to interact with the mechanisms merely by using brain activity. These interfaces acquire brain signals, analyze them, and translate them into commands executed by the output devices.

We have approximately 86 billion neurons, all of them individually linked to other neurons. When we move, think, feel, our neurons are at play. For almost every task, electrical signals move through these neurons. BCIs here analyze the patterns of these electrical signals, giving us an overview of what's going on in the brain. Typically, electrodes are placed on the scalp to gather these signals.

Table 1:
Different types
of signals

Type	Description	Material used in building these sensors	How the signals are collected (invasive / non-invasive)	Applications
EMG (Electromyography)	Records electrical activity produced by skeletal muscles.	Conductive gel, metals like silver/silver chloride	Electrodes on the skin (Non-invasive)	<ul style="list-style-type: none"> • Diagnose neuromuscular disorders • Assess muscle function • Guide biofeedback therapy
EEG (Electroencephalogram)	Records electrical activity in the brain.	Electrodes of silver chloride, gold, or stainless steel	Electrodes on the scalp (Non-invasive)	<ul style="list-style-type: none"> • Diagnose, monitor neurological conditions • Study brain activity • Research cognitive processes.
ECoG (Electrocorticography)	Maps brain functions and monitors brain activity.	Platinum, gold or biocompatible metals	Electrodes on the cerebral cortex (Invasive)	<ul style="list-style-type: none"> • Precise brain mapping during epilepsy surgery • Studying brain functions • Development of BCI's
fMRI (Functional Magnetic Resonance Imaging)	Measures blood flow changes in the brain.	Niobium Titanium (NbTi)	Machine (Non-invasive)	<ul style="list-style-type: none"> • Diagnose neurological conditions • Map functional areas • Research cognitive processes.

The above table, as we can see, discusses the sensors used to record electrical activities from various parts of the body.

Electromyography (EMG) sensors record the electrical activity produced by the skeletal muscles during contraction and at rest. These typically use conductive gel, and metals like silver or silver chloride, and are placed on the skin, thus making it non-invasive. EMG is useful in diagnosing neuromuscular disorders, assessing muscle function, and guiding biofeedback therapy.

Electroencephalography (EEG) sensors typically capture electrical activity in the brain. They use electrodes made of silver chloride, gold, or stainless steel, which are placed on the scalp, making it non-invasive. EEG is commonly useful to diagnose and monitor neurological conditions, from epilepsy, sleep disorders, brain tumours, head injuries, to dementia and Alzheimer's disease.

Electrocorticography (ECoG) sensors provide mapping of brain functions. They use biocompatible metals like platinum or gold. These sensors are placed directly on the cerebral cortex and requires surgery. Thus, this is an invasive method. ECoG is primarily used to map the brain precisely during epilepsy surgery. These are also used to develop BCI's.

Functional Magnetic Resonance Imaging (fMRI) measures changes in blood flow in the brain. This technique uses a machine with materials such as NbTi (Niobium Titanium) and is non-invasive. fMRI is used to diagnose neurological conditions, and also research cognitive processes.

EEG headsets are wearable devices. They capture and interpret the electrical signals produced by neural activity, providing insights into the emotional, cognitive, and physiological states.

The core consists of electrodes embedded in a cap (or headband), placed in a standardized placement.

The electrodes used in EEG headsets can either be wet or dry. Wet electrodes require conductive gel, however, this can sometimes be less convenient. Dry electrodes, on the other hand, use mechanisms to maintain contact without the need for any gel. Modern EEG headsets have evolved to include even wireless models. Wired headsets transmit signals directly to a computer through a cable. They use Bluetooth or Wi-Fi to send data.

Signal capturing involves the electrodes detecting minute voltage fluctuations that result from neuronal activity. These weak signals, however, require amplification to be used. The amplified signals are then processed by software. The software filters out noise and extracts the features. This software is also capable of performing signal pre-processing, feature extraction, connectivity mapping, etc.

EEG software supports real-time processing and feedback. This is essential for BCI's, enabling users to receive immediate feedback based on their brain activity.

This can be used to control external devices, train cognitive behavior and even implement for conditions like epilepsy.

Each cycle of a brain wave represents a full oscillation. Frequencies as defined by the number of cycles per second (Hz), are within the audible range of 20Hz to 20kHz.

EEG signals are characterized by their amplitude (measured in microvolts) and frequency (measured in Hertz).

Different frequency ranges indicate various brain states -

Alpha waves (8–14 Hz) are linked to relaxation

Beta waves (14–30 Hz) are linked to alertness, and

Gamma waves (over 30 Hz) are linked to high-level cognitive processing.

Delta waves (0.5 – 4Hz):	<ul style="list-style-type: none">• Patients with severe insomnia sometimes undergo neurofeedback therapy, which promotes sleep quality.• People recovering from brain injury undergo EEG monitoring (delta waves) to assess brain function during rehabilitation.
Theta waves (4 – 8Hz):	<ul style="list-style-type: none">• Patients with epilepsy are monitored with EEG to detect seizure activity. Increased theta wave activity is observed before a seizure.
Alpha waves (8 – 14 Hz)	<ul style="list-style-type: none">• Patients with motor dysfunctions can move their affected arm. This shows changes in the alpha wave activity in the motor cortex.• Prosthetic limbs can be controlled by brain signals. Changes in the waves are detected, enabling biofeedback and a sense of control with prosthetics.
Beta waves (14 – 30 Hz):	<ul style="list-style-type: none">• Patients with Parkinson’s can perform specific motor tasks while the increased beta wave activity is recorded.
Gamma waves (> 30 Hz):	<ul style="list-style-type: none">• Helps diagnose patients with memory-related diseases, like Alzhiemers.• Improving cognitive function and memory recall with increased gamma waves, stimulating the brain during activities.

Table 2: Applications of different waves

These waves can provide valuable insight about a person’s mental state, sleep pattern, or even certain neurological conditions.

ERD AND ERS

ERD (Event related desynchronization) and **ERS (Event related synchronization)** are measures used to understand the changes in the mentioned brain wave activities.

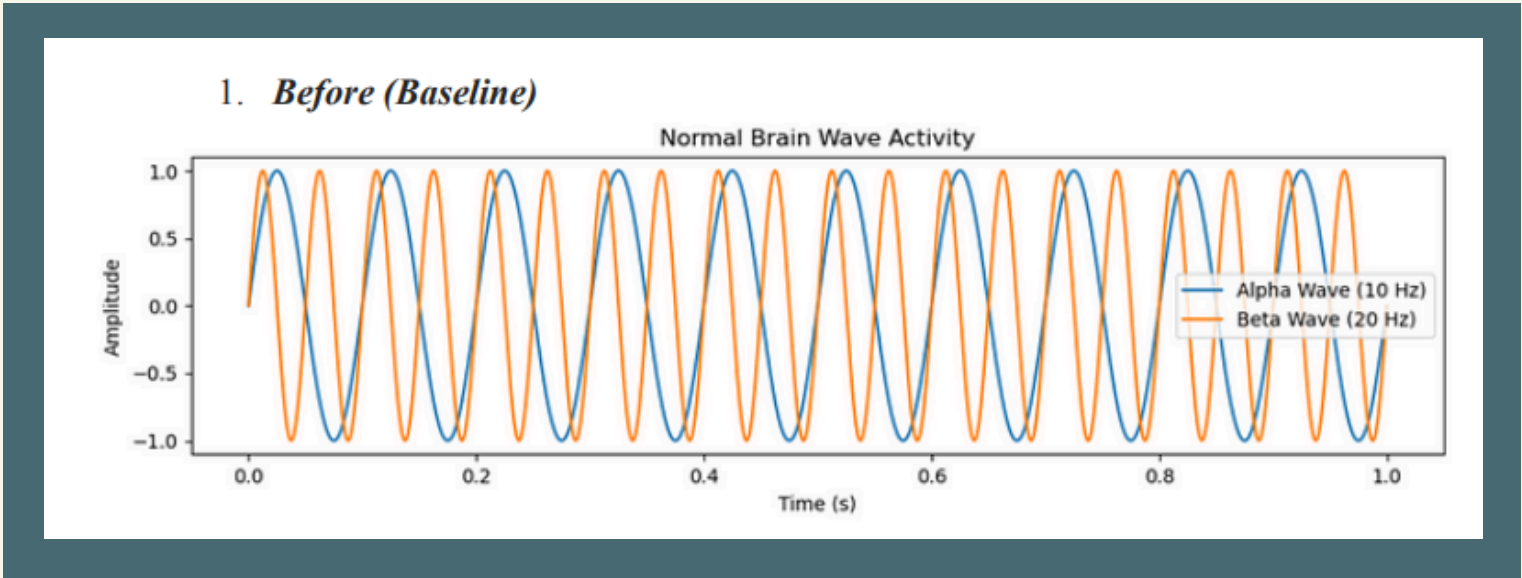
ERD refers to a decrease in power of frequency bands which indicates brain activation. ERS, refers to increase in power of frequency bands which indicates relaxation.

Let’s look at an example of what happens in the brain when someone imagines moving their left hand:

- (i) Baseline state** — When the person is not thinking about moving his/her hand, the brain shows a normal pattern of waves.
- (ii) Imagining Movement** — When the person starts imagining moving their left hand, specific changes occur in brain waves.

- Alpha Waves decrease, showing that the brain is active and engaged in the task
- Beta Waves increase implying focused attention and preparation for movement.

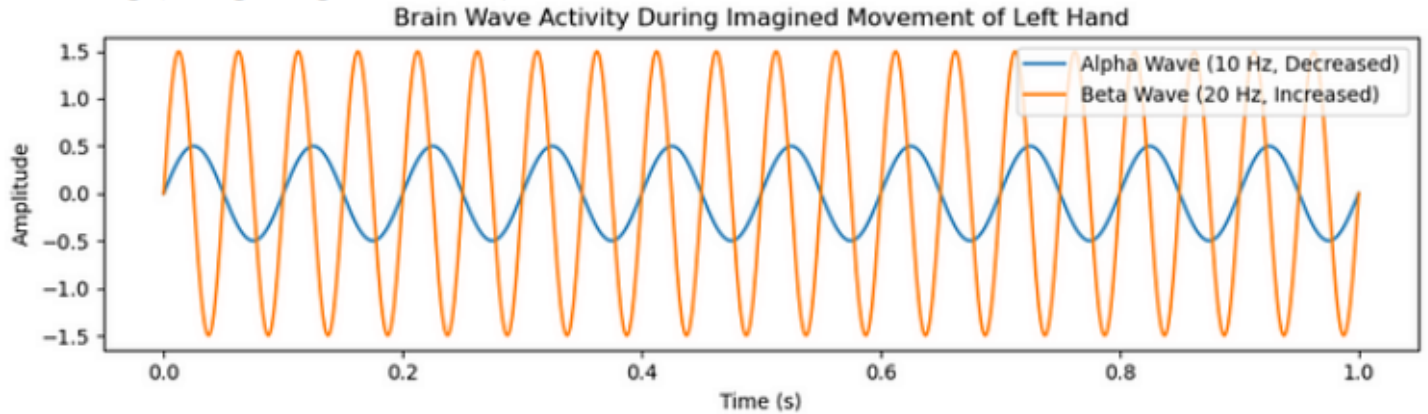
Below are diagrams showing how brain waves change when a person imagines moving their hand:



Graph 1.1: Normal Brain Activity

Here, we can see normal alpha and beta waves, indicating that there is no particular movement.

2. During (Imagining movement)



Graph 1.2: Brain Wave Activity During Imagined Movement of Left Hand

In this, we can notice that the alpha waves (associated with relaxation) are decreased, while the beta waves (associated with alertness and concentration) are increased. This helps us conclude that while performing an imagined movement, there are higher concentration levels.

These patterns help us conclude that through BCI's, we can control various different actions. These can especially be useful for people with movement impairments and can also open new avenues for understanding the functions of our brains.

From enabling amputees to control robotic limbs with their thoughts, to allowing individuals with locked-in syndrome to communicate to their loved ones or assist doctors to help diagnose them, BCI's have proved to improve the quality of life, in therapeutic, medical, and everyday applications.

ELEMENTAL



CONTENTS

01 Plastics

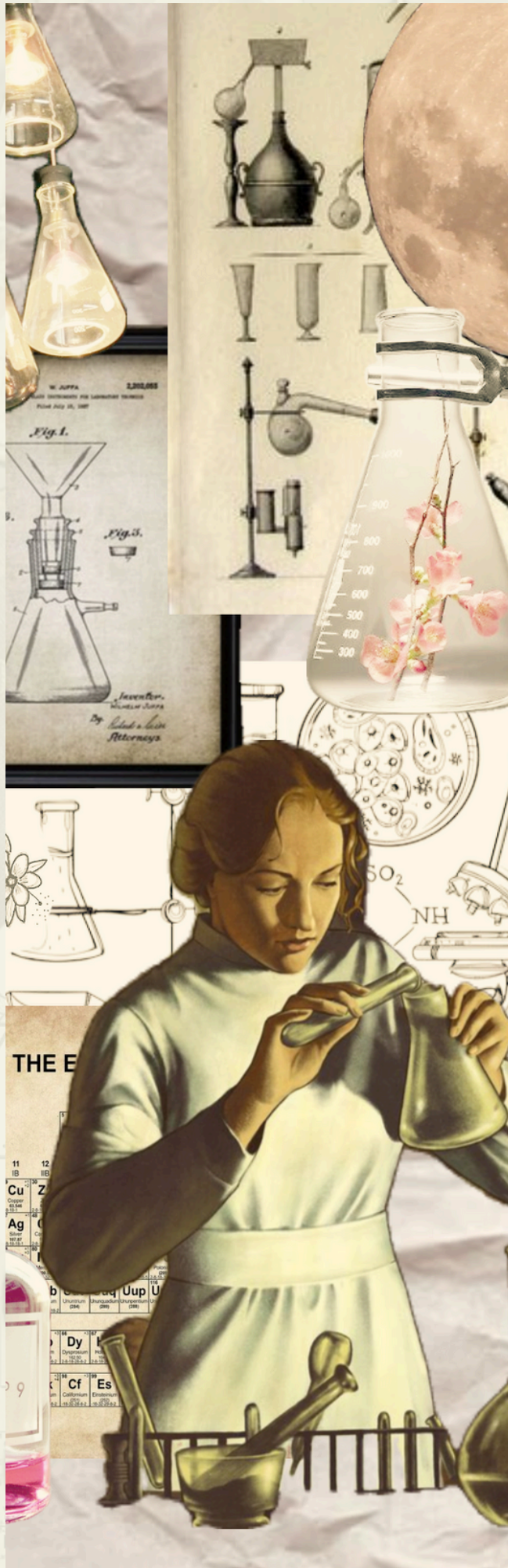
02 Titration Tales

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05 The Chemistry of Taste

06 Comic



PLASTICS

~ Hridan Setia
Class: XI-R

01

What are plastics?

1. **Plastics:** Synthetic materials made from long chains of molecules called **polymers**.
2. **Polymers:** Large molecules formed by chemically bonding smaller molecules, called **monomers**, together.
3. **Monomers:** Basic building blocks of plastics, typically derived from hydrocarbons like **ethylene (C₂H₄)** and **propylene (C₃H₆)**.

Types of Plastics

1. **Thermoplastics:** Can be melted and reshaped multiple times (e.g., polyethylene, polypropylene).
2. **Thermosetting Plastics (Thermosets):** Harden permanently after molding and cannot be remelted (e.g., epoxy resin).
3. **Biodegradable Plastics:** Break down naturally over time through biological processes (e.g., polylactic acid, PHAs).

How are they made?

1. **Raw Material Extraction:** Plastics are made from crude oil or natural gas, containing hydrocarbons like ethane (C₂H₄) and propane (C₃H₆).
2. **Cracking:**
 - a. Hydrocarbons are broken down into smaller molecules, such as ethylene (C₂H₄) and propylene (C₃H₆), using heat and catalysts.
 - b. $C_3H_8 \rightarrow C_2H_4 \text{ (ethylene)} + CH_4 \text{ (methane)}$
3. **Polymerization:** Monomers like ethylene and propylene undergo polymerization to form long polymer chains.

For ethylene: $n C_2H_4 \rightarrow (C_2H_4)_n$ (Polyethylene)

For propylene: $n C_3H_6 \rightarrow (C_3H_6)_n$ (Polypropylene)
4. **Shaping into Products:** The polymer is then heated and moulded into final products using processes like extrusion, injection moulding, or blow moulding.

02

TITRATION

TALES

~ Pratyusha Pal
Class: XII- Q

In every drop, in every swirl, it's a dance,
Where science meets with art's embrace.

For in the titration's subtle steps, where patience reigns supreme,
The secrets of the smallest drops can craft the grandest dream.
With steady hands, the teacher guides the slender pipette's tip,
And from it falls a single drop, a patient, measured drip.

The indicator, watchful, keen, awaits its cue to play,
To signal when the balance tips, when pale pink gives way.

A drop, another, slowly falls, and tension fills the air,
As colors hint, then dance away, with promises laid bare.

The end point nears, the colors shift, a blush of pink, then clear,
The moment holds its breath as all the unknowns now appear.
The student's hand, so steady, sure, guides each drop with care,
Eyes fixed upon the changing hues that swirl and mix and share.

The moment comes, the tipping point, where the indicator smiles,
And in a flash, the colors bloom, across the liquid miles.

A final drop, the line is crossed, the truth at last revealed,
The measured volumes, carefully gauged, have broken what was
sealed.

The students smile, the work is done, the experiment complete,
In every note of acid-base, a fun so sweet.

The flasks are cleaned, the pipettes rest, the lab returns to calm,
The titration's tale, a story told, in measures of the chemistry realm..

CRYSTALS

03

~ Mohajit Debnath 11 -I
Balaji Saketh 11 - I

Let's Talk about crystals

Crystals, the shiny and rare rocks we come across once in a while -be it when we see a jeweller selling them, or an astrologist using them for predicting the future- are not only fascinating to look at, but they are also a very fundamental and misunderstood part of our lives, playing the most vital role in chemistry. But what even are they?

In the simplest terms, crystals are structures composed of atoms, molecules or ions in a very precise and repeating structure known as a "lattice structure". Some common structures include -



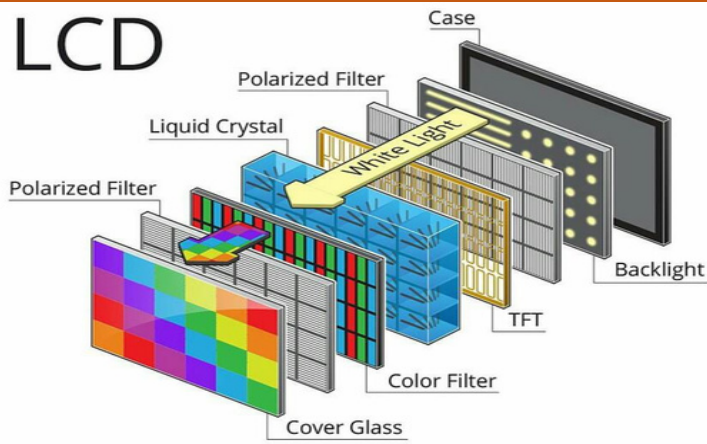
Amythyst



Sapphire

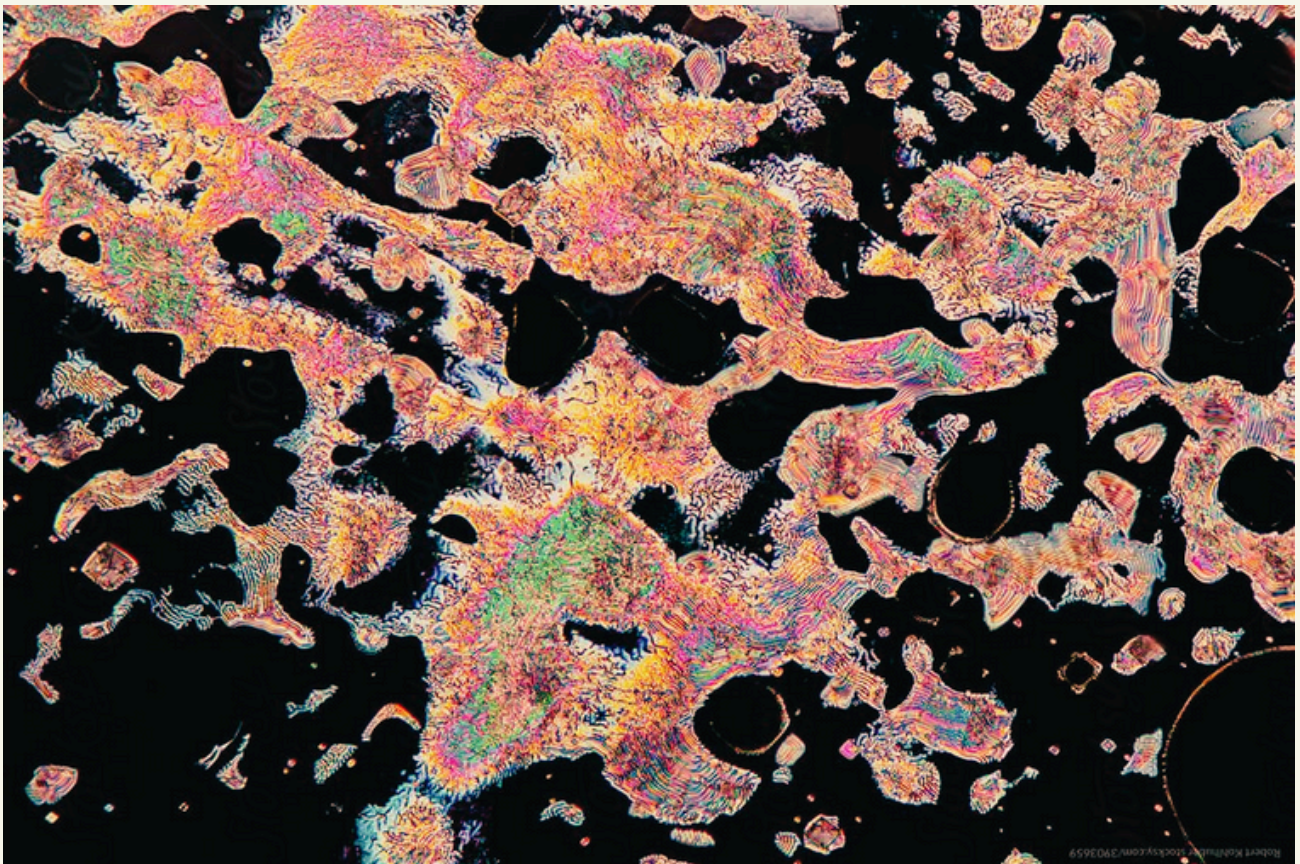
These lattice structures are what give crystals their unique shapes and properties. These beautiful substances attracted us for not only their unique applications in technology, aerospace and chemistry but also our ancestors, who used them for a variety of purposes ranging from using their healing properties and using them as talismans. Even now, studies have shown that certain crystals emit something known as "negative ions", which are also released from waterfalls, ocean waves, forests, etc. Recent studies have also shown that these negative ions aid in mood enhancement, improved respiration, etc.

LCD



" Apart from only boosting our mood and overall health, crystals have played a vital role in the development of humanity. Most of you must have heard the term "LCD", but most of us do not know what it is, fun fact LCD (liquid crystal displays) use the unique property of crystals when they are under electric forces to generate colours and images.

These simple yet sophisticated crystals are all around us, ranging from the food we eat to the mobile devices we use daily, the vibrant and fancy colours of rare and precious gemstones, to something as simple as the aluminium foil we use to pack our food shows us that the crucial and integral role crystals play in our lives cannot be ignored!



The Dangers of Microplastic in Paper Cups

Paper cups are often seen as a healthier and more environmentally friendly alternative to plastic cups. However, this perception is far from reality. While they may seem harmless, paper cups harbour a hidden danger—a thin plastic lining. This lining, invisible to the naked eye, is essential to prevent the paper from getting wet and leaking. Unfortunately, this seemingly innocuous solution has significant implications for our health and the environment.

The plastic lining inside paper cups is typically made of polyethylene or polypropylene. These polymers are derived from petroleum and are known for their resistance to water and chemicals. While they may seem harmless at first glance, these plastics can release harmful chemicals into our beverages, especially when exposed to heat or acidic liquids.



One of the most concerning aspects of paper cups is their contribution to microplastic pollution. Microplastics are tiny plastic particles that can enter our bodies through drinking water, seafood, and other sources. Studies have shown that paper cups can release billions of microplastic particles into our drinks within the first 15 minutes of use. These microplastics can have adverse effects on our health, including digestive problems, hormonal imbalances, and potential long-term health risks.

Beyond their health implications, paper cups also have a significant environmental impact. While they may be biodegradable, the process of breaking down paper cups can release harmful chemicals into the environment. Additionally, the production of paper cups requires a significant amount of energy and resources, contributing to deforestation and greenhouse gas emissions.

Given the drawbacks of paper cups, it is essential to explore more sustainable alternatives. Glass reusable containers are a promising option. Unlike paper cups, glass is non-porous and does not require a plastic lining. This means that there is no risk of microplastic contamination or chemical leaching. Additionally, glass is infinitely recyclable and has a much lower environmental impact than paper cups.



To address the problem of paper cups, it is crucial to raise awareness about their hidden dangers and promote the use of reusable containers. Schools, universities, and businesses can play a significant role in implementing policies that discourage the use of single-use paper cups. By educating the public and providing alternatives, we can make a positive impact on our health and the environment.

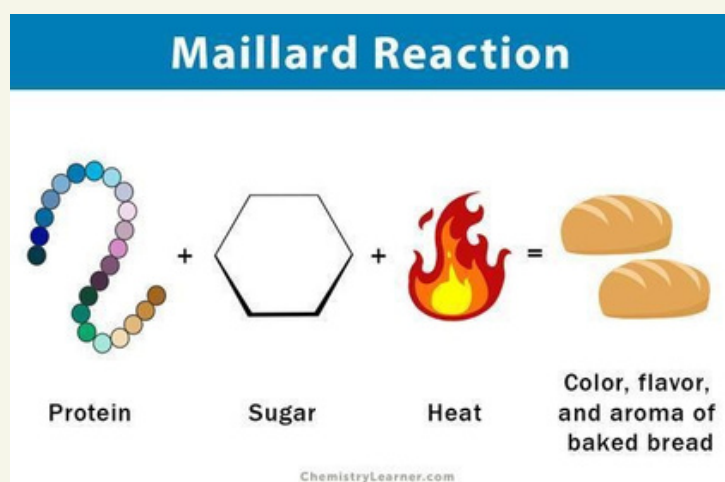


THE CHEMISTRY OF TASTE

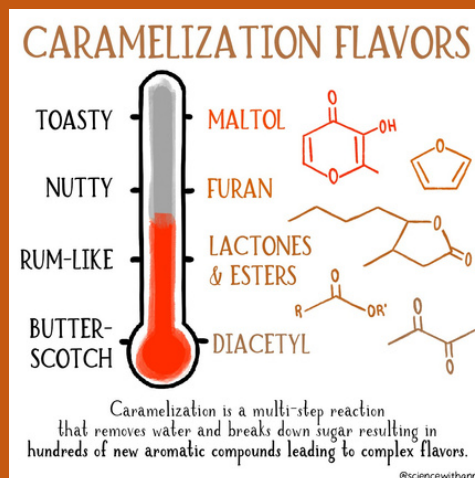
~SARVESH IYER
Class 12L

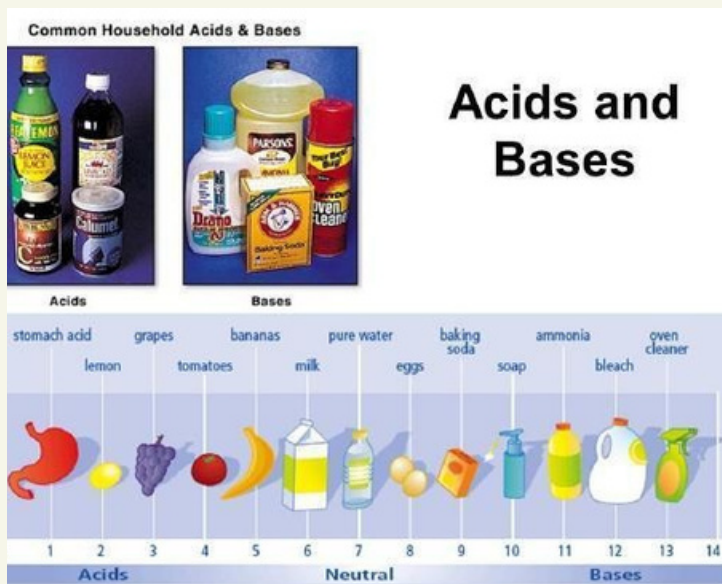
05

You should always know what you are eating, especially if you are a health conscious person. Chemistry significantly influences taste through various reactions. The Maillard reaction, for instance, occurs when proteins and sugars in food react under heat, creating rich, savoury flavours and brown colours. This reaction is responsible for the delicious crust on freshly baked bread and the caramelised edges of a seared steak, contributing to complex and deep flavours.



Caramelization is another key process, where sugars are heated to high temperatures, breaking down into new compounds and producing flavours ranging from sweet to bitter. This transformation is essential in creating the rich flavours of caramel sauce, toffee, and the golden crust of baked goods. The sweetness and depth of caramel candies are direct results of this reaction. I'm sure all of you reading this have a sweet tooth!





Acid-base reactions also play a crucial role in taste. For example, the tangy flavour of citrus fruits comes from citric acid, while the sour taste of vinegar is due to acetic acid. These acids can enhance and balance flavours in dishes, such as using lemon juice to brighten up salmon or vinegar in salad dressings. Baking soda, a base, can neutralise acidity, affecting both flavour and texture.

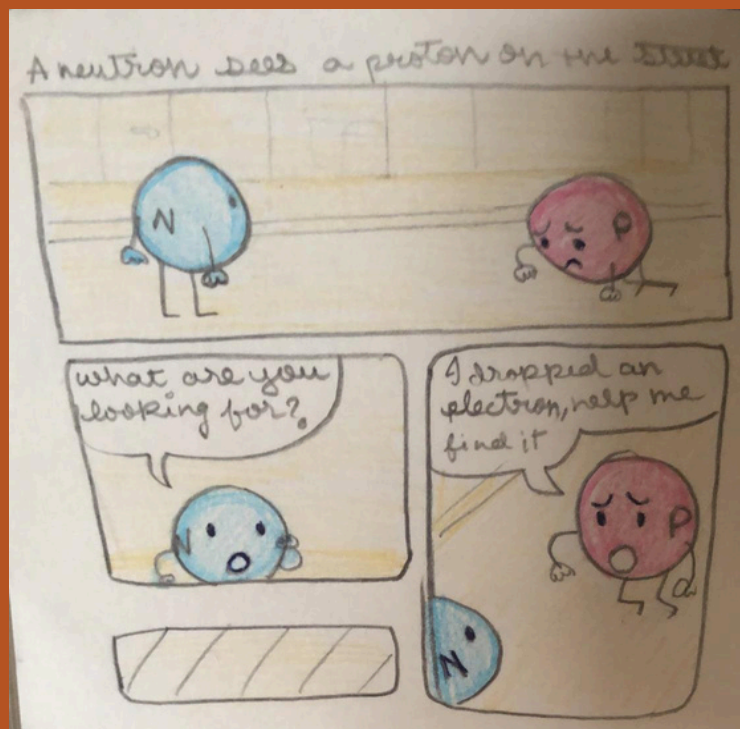
Enzymatic reactions are vital for developing flavours in cheese and wine. Enzymes break down complex molecules into simpler ones, creating new flavours and aromas. For instance, enzymes in cheese-making break down milk proteins into peptides and amino acids, which shape the cheese's distinctive taste. Similarly, wine ageing involves enzymatic reactions that enhance flavour and aroma.



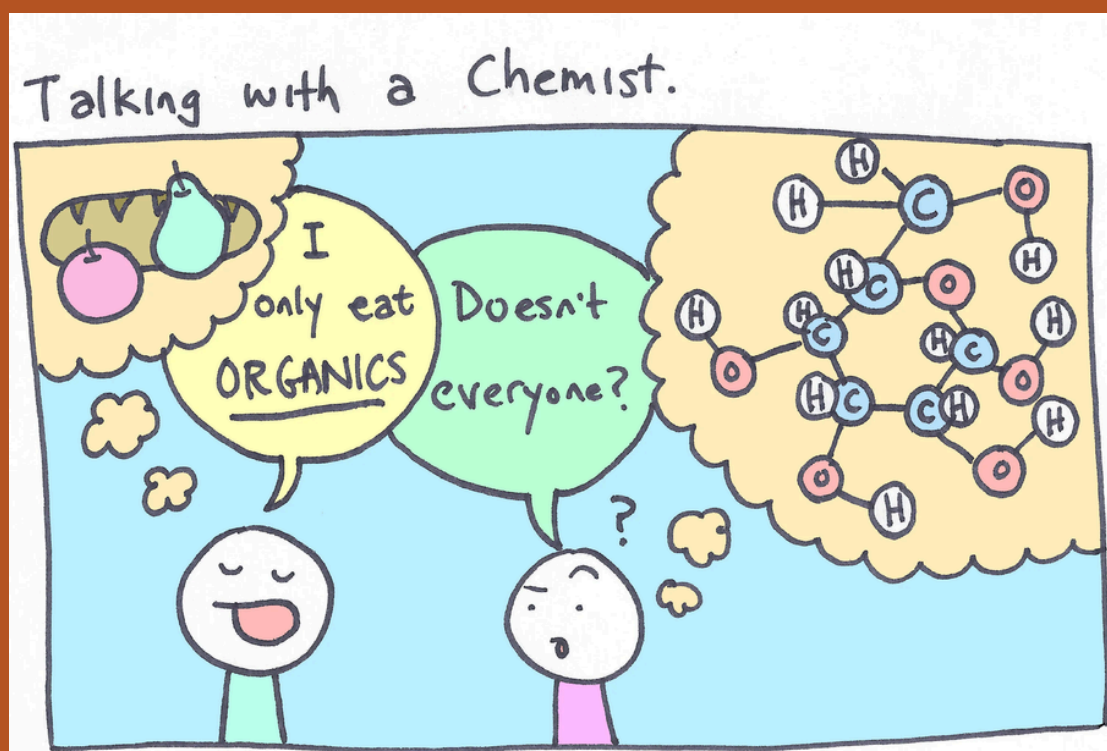
The interaction of sweet, salty, sour, and bitter flavours creates a balanced and harmonious taste experience. The chemistry of taste is not just about individual reactions but also about how these reactions work together to produce complex flavours. Understanding these processes enriches our appreciation of food and opens doors for culinary creativity. And now, you know exactly what's happening on your tongue!

06

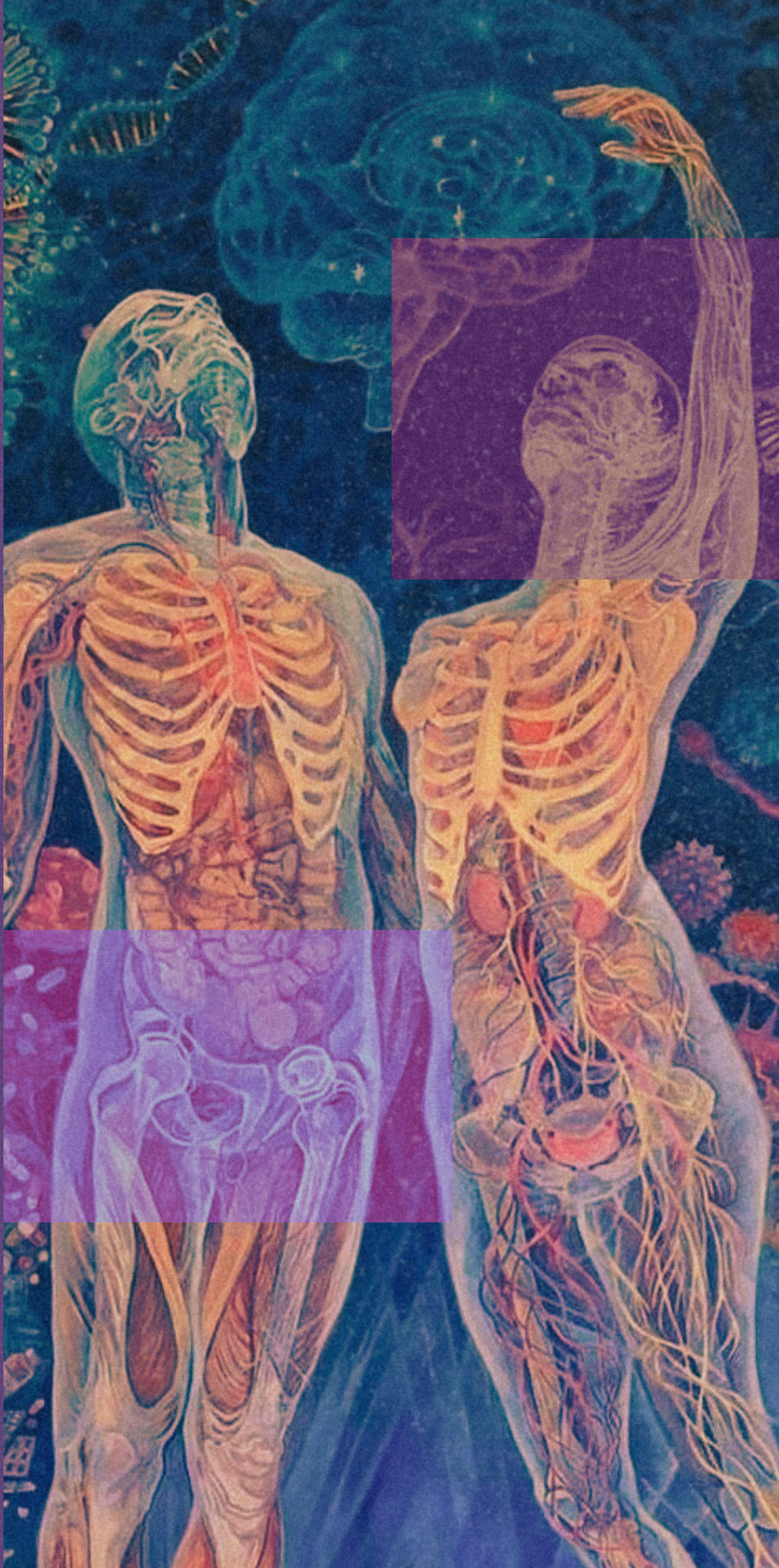
COMICS



~ARPITHA PV Class II S



METAMORPHOSIS





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CIRCADIAN RHYTHMS AND IMPORTANCE OF SLEEP

-PRATYUSHA PAL
XII-Q

01

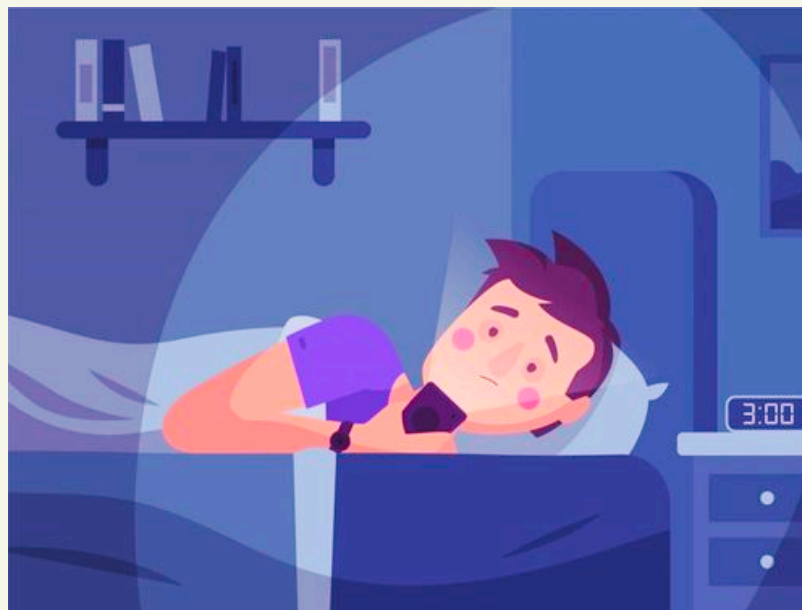
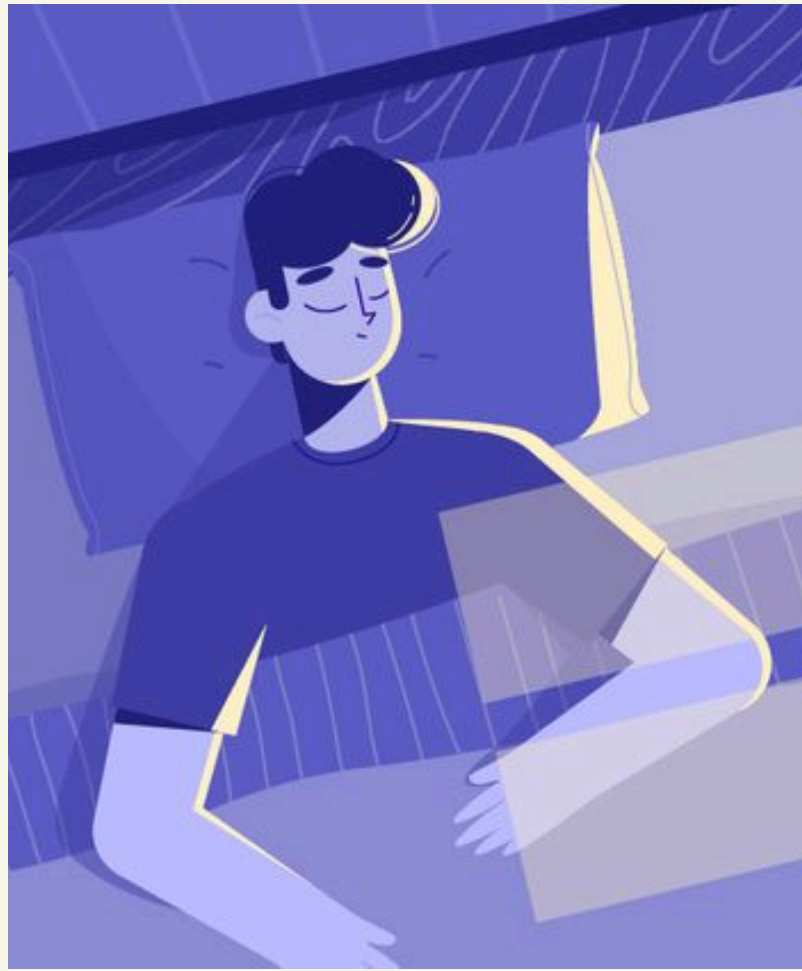
Why is sleep so crucial to our well-being? Could we truly function at our best without it? Maintaining a regular sleep schedule aligned with natural circadian rhythms promotes optimal health, enhancing mood, cognitive performance, and overall physiological function. Sleep itself is a complex and dynamic state crucial for physical and mental well-being. During sleep, the body undergoes various restorative processes, including memory consolidation, tissue repair, and metabolic regulation. Sleep is divided into two main stages: Non-Rapid Eye Movement (NREM) and Rapid Eye Movement (REM) sleep, each playing distinct roles in health. NREM sleep facilitates deep restorative functions, while REM sleep is essential for cognitive processes such as learning and emotional regulation.

Circadian rhythms are the internal biological processes that follow a roughly 24-hour cycle, regulating various physiological functions including sleep-wake patterns, hormone release, and body temperature. These rhythms are governed by the brain's suprachiasmatic nucleus (SCN), which responds to environmental cues like light and darkness to synchronize the body's internal clock with the external day-night cycle.

Disruptions to circadian rhythms, such as those caused by irregular sleep patterns, shift work, or jet lag, can significantly impact health by affecting sleep quality, mood, and cognitive function. Circadian rhythms and sleep patterns change with age. For instance, older adults often experience changes in sleep architecture and circadian rhythm shifts, leading to earlier sleep and wake times and reduced sleep quality. Also, Consistently good sleep contributes to a higher quality of life, improving mood, relationships, and overall satisfaction with life. It enhances daily functioning and supports a balanced, fulfilling lifestyle. Adequate sleep supports cardiovascular health by regulating blood pressure and reducing inflammation. Chronic sleep deprivation is linked to an increased risk of hypertension, heart disease, and stroke. Sleep influences metabolism by regulating appetite hormones like leptin and ghrelin. Poor sleep can disrupt these hormones, leading to increased hunger, cravings, and potential weight gain. Regular, restorative sleep supports healthy behaviour and decision-making. Sleep deprivation can lead to impulsive behaviour, poor decision-making, and decreased ability to manage emotions and stress.

Sleep plays a critical role in memory consolidation, the process by which new information is stabilized and integrated into long-term memory. Both REM and deep sleep stages contribute to different types of memory, including procedural and declarative memory. Quality sleep helps build emotional resilience, allowing individuals to cope better with stress and setbacks. Poor sleep can exacerbate emotional reactivity and make it harder to manage challenges effectively. During sleep, the brain's glymphatic system becomes more active, clearing out toxins and metabolic waste products that accumulate throughout the day. This detoxification process is essential for maintaining cognitive health and preventing neurodegenerative diseases. During sleep, the body undergoes essential repair and recovery processes, including muscle growth and tissue repair. Quality sleep improves physical performance, endurance, and overall recovery from physical exertion. Good sleep is essential for emotional stability. It helps regulate mood and reduces the risk of mental health issues such as anxiety and depression. Sleep influences how we handle stress and interact with others.

In essence, good sleep is foundational to a healthy, balanced life, influencing every aspect of our physical and mental health. Prioritizing quality sleep can lead to improved health, enhanced performance, and a better quality of life.

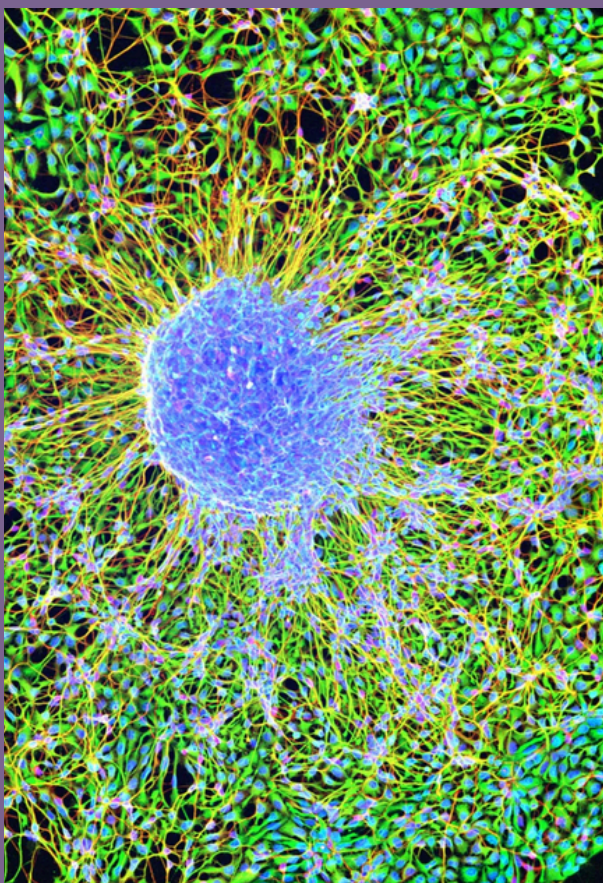


02 STEM CELL RESEARCH

~ Advancing the science of tissue repair and regeneration.

-PRATYUSHA PAL
XII-Q

Stem cell research stands at the forefront of modern biological science and medicine, offering profound potential for revolutionizing the treatment of a myriad of diseases and injuries. Stem cells, characterized by their ability to differentiate into various cell types and their potential for self-renewal, have captivated researchers with their promise of regenerative medicine and cellular therapies. There are two main types of stem cells: embryonic stem cells (ESCs) and adult (or somatic) stem cells. ESCs, derived from early-stage embryos, possess pluripotency, meaning they can develop into almost any cell type in the body. This remarkable capacity makes them invaluable for studying early human development and for potential applications in regenerative medicine. However, the use of ESCs raises ethical concerns related to the destruction of embryos, sparking ongoing debates and leading to the development of alternative approaches.



Adult stem cells, found in various tissues throughout the body, have a more restricted differentiation potential compared to ESCs but still hold significant promise. These include hematopoietic stem cells from bone marrow, which are already utilized in bone marrow transplants for treating blood disorders like leukemia and lymphoma. More recently, researchers have explored the potential of mesenchymal stem cells (MSCs) from adipose tissue, umbilical cord blood, and other sources for their ability to differentiate into bone, cartilage, and fat cells, offering new avenues for tissue repair and regenerative treatments. A groundbreaking advancement in stem cell research is the development of induced pluripotent stem cells (iPSCs).

These are adult cells reprogrammed to acquire pluripotent capabilities similar to ESCs, thereby bypassing some of the ethical issues associated with using embryos. iPSCs have the potential to generate patient-specific cell lines for studying disease mechanisms, drug testing, and even personalized therapies.

Despite the remarkable progress, stem cell research faces significant challenges. One major concern is ensuring the safety and efficacy of stem cell therapies. The risk of tumor formation from uncontrolled cell growth and the potential for immune rejection of transplanted cells are ongoing issues that need to be addressed through rigorous research and clinical trials. Additionally, the complexity of differentiating stem cells into functional, mature cell types that integrate seamlessly into existing tissues is a significant hurdle. Researchers are also working to improve methods for scaling up cell production and ensuring quality control to meet the demands of clinical applications.



Ethical considerations continue to play a crucial role in guiding stem cell research. The debate over the use of embryonic stem cells has led to the establishment of regulatory frameworks and ethical guidelines aimed at balancing scientific progress with moral concerns. In parallel, the development of iPSCs has provided a promising alternative, but it also raises new questions about the long-term implications of reprogramming adult cells and their potential use in clinical settings.

The future of stem cell research is promising, with ongoing advancements in understanding stem cell biology, refining techniques for cell differentiation, and developing new therapeutic applications. Innovations in gene editing technologies, such as CRISPR, are likely to further enhance the capabilities of stem cells and expand their potential uses. As research progresses, it holds the potential to transform the landscape of medicine, offering hope for effective treatments and cures for previously intractable conditions, thereby significantly impacting human health and quality of life.

THE AMAZING WORLD OF PHEROMONE

~ BIDHATRIKA BANERJEE,
XII P

Humans have the tendency of being curious. We observe nature and very fascinating things which may seem trivial, but are not in real life. One of these is the working of the Pheromone.

Pheromone is a chemical factor that is secreted which triggers a social response in members of the same species. These act like hormones outside the body of a secreting individual, to affect the receiving individual. The functionality of pheromone is observed mostly in social insects or organisms like bees, ants, termites, wasps etc.

Let us discuss some aspects of the working of Pheromone in ants and bees.

ANTS -

Venomous ants use their sting to lay down a product of the poison glands as a trail pheromone, while non-venomous ants synthesize their pheromone in the gut. The trail pheromones are used to show the trail of the food source. These serve as a sensitive index to the amount of food present at a distant location, because each worker returning from the resource



adds to the trail's intensity. Once the food is exhausted, returning workers no longer lay down a trail and it soon dissipates. Trail pheromones are relatively volatile (evaporates easily), a necessity if trails that are no longer informative are to be avoided. Desert ants searching for dead insects (or anthropoids) do not employ trail pheromones as that would not last long in the heat. So they use path integration based on a skylight compass and visual landmarks to navigate. They are also able to use the odor they have associated with their nests to identify and return to the nest entrance.

BEES -

Bees use many different types of pheromone for their survival. Let us discuss a few here. Alarm pheromone, produced by worker bees, is a pheromone that calls nest mates to help defend the colony from intruders. A sting, which also releases an alarm pheromone, causes other bees to sting as well. Queen mandibular pheromone (QMP) plays many roles in the hive, including regulating social behavior, swarming, mating, and suppressing laying workers.



Often known as “queen substance” the pheromone is spread throughout the hive by the worker bees, thereby alerting colony members that the hive is “queen-right” and operating normally. Worker Pheromone is produced by foraging bees (bees who collect food) that slows the maturation of nurse bees (bees taking care of larvae) into forager bees. This is done to maintain the balance of the forager and nurse bees in the colony. Egg marking Pheromone allows worker bees to distinguish between queen-laid eggs and worker-laid eggs. At one time, scientists believed that the Dufour’s gland pheromone (helped in interactions between queens and workers, and between laying workers and non-laying workers) marked a queen’s eggs, but now egg-marking pheromone appears to be separate.

There are many other behavioral aspects in the insect world and in the higher order animals as well controlled by Pheromone. Many of the functions of nature are still unknown to us, but with the development of science and technology, we hope to understand nature better and unveil its secrets towards brilliance in simplicity. This is the fascinating world of Biology.

04 UNDERSTANDING THE MECHANISMS OF IMMUNITY AND RESISTANCE OF THE HUMAN BODY TO ANTIBIOTICS

~ SONIA BASRANI,
XIM

Introduction to Antibiotics and Their Importance in Medicine

Antibiotics have revolutionized the field of medicine since their discovery in the early 20th century. These powerful drugs are used to combat bacterial infections by inhibiting bacterial growth or killing bacteria directly. Penicillin, the first antibiotic discovered by Alexander Fleming, marked the beginning of a new era in medical treatment, drastically reducing mortality rates from bacterial diseases and enabling complex surgical procedures. Despite their profound impact, the overuse and misuse of antibiotics have led to a growing concern about antibiotic resistance, a major public health issue that threatens to undermine the effectiveness of these critical medications.



The Immune System: An Overview

The immune system is a complex network of cells, tissues, and organs that work together to defend the body against pathogens, including bacteria, viruses, and fungi. It is broadly categorized into two types: innate immunity and adaptive immunity.

Innate Immunity

Innate immunity is the body's first line of defense and responds to pathogens in a non-specific manner. It includes physical barriers such as the skin and mucous membranes, as well as immune cells like macrophages, neutrophils, and natural killer (NK) cells. These components recognize and respond to common features of pathogens, such as bacterial cell wall components, using pattern recognition receptors (PRRs). The innate immune response is rapid but lacks the specificity and memory characteristic of adaptive immunity.

Adaptive Immunity

Adaptive immunity, also known as acquired immunity, develops more slowly but provides a highly specific response to pathogens. It involves two main types of lymphocytes: B cells and T cells. B cells produce antibodies that bind to specific antigens on pathogens, marking them for destruction or neutralization. T cells, on the other hand, can directly kill infected cells or help other immune cells. Importantly, adaptive immunity has a memory component, which allows the immune system to respond more efficiently upon subsequent exposures to the same pathogen.

Mechanisms of Antibiotic Action

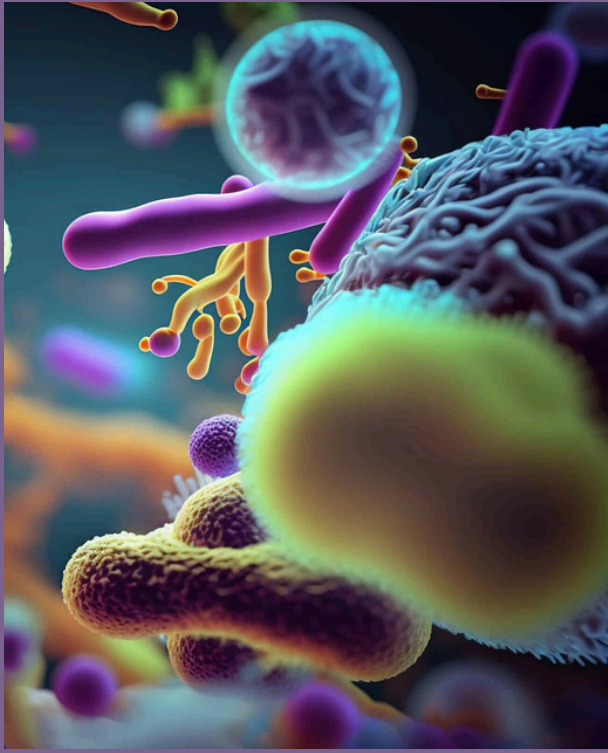
Antibiotics target specific bacterial structures or functions to inhibit bacterial growth or kill bacteria. The mechanisms of action vary depending on the class of antibiotic:

- **Cell Wall Synthesis Inhibitors:** Antibiotics like penicillin and cephalosporins interfere with the synthesis of bacterial cell walls, leading to cell lysis and death. These antibiotics target enzymes involved in cell wall construction, such as penicillin-binding proteins.
- **Nucleic Acid Synthesis Inhibitors:** Some antibiotics, including quinolones, inhibit bacterial DNA replication or transcription by targeting enzymes like DNA gyrase or topoisomerase IV, essential for maintaining DNA structure and function.
- **Metabolic Pathway Inhibitors:** Sulfonamides and trimethoprim interfere with bacterial metabolic pathways, such as folic acid synthesis, which is crucial for nucleic acid synthesis and bacterial growth.
- **Protein Synthesis Inhibitors:** Antibiotics such as tetracyclines and macrolides inhibit bacterial protein synthesis by binding to ribosomal subunits. This disruption prevents bacteria from producing essential proteins needed for growth and replication.

Immune Response to Antibiotics

The human immune system does not typically recognize antibiotics as foreign agents since they are designed to target bacterial components rather than human cells. However, some antibiotics can cause allergic reactions or hypersensitivity in certain individuals. These reactions can range from mild rashes to severe responses. The immune system's role in managing such reactions involves the production of specific antibodies against the antibiotic, mediated by B cells, and the activation of other immune pathways that lead to inflammation and tissue damage.





Development of Antibiotic Resistance in Bacteria
Antibiotic resistance occurs when bacteria evolve mechanisms to evade the effects of drugs that once killed them or inhibited their growth. This resistance poses a significant challenge to public health and is driven by several factors:

1. Genetic Mutations

Bacteria can acquire resistance through spontaneous genetic mutations. These mutations may alter the drug's target site, reduce drug uptake, or increase drug efflux. For example, mutations in the genes encoding penicillin-binding proteins can render bacteria resistant to beta-lactam antibiotics.

2. Horizontal Gene Transfer

Horizontal gene transfer (HGT) allows bacteria to acquire resistance genes from other bacteria through processes such as conjugation, transformation, and transduction. Conjugation involves the transfer of plasmids carrying resistance genes between bacteria through direct contact. Transformation occurs when bacteria take up free DNA from their environment, and transduction involves the transfer of DNA by bacteriophages (viruses that infect bacteria). HGT enables the rapid spread of resistance genes within and between bacterial populations.

Conclusion

The interplay between antibiotics and the human immune system is a complex and dynamic process. While antibiotics are essential tools in combating bacterial infections, the emergence of antibiotic-resistant bacteria poses a growing threat to global health. Understanding the mechanisms of antibiotic action and the factors driving resistance is crucial for developing effective strategies to preserve the efficacy of these life-saving drugs. Continued research, prudent antibiotic use, and novel therapeutic approaches are needed to address the challenges of antibiotic resistance and ensure that antibiotics remain effective for future generations.

THE HUMAN HEART – A CONSCIOUS CONUNDRUM?

~ SIRI R
XI S

The human heart, an astonishing paradox, has always been a symbol of love.

Poets have often homogenized the heart to have a direct correlation with resilience, compassion, warmth, strength. Our emotions are enough proof that energy flows through our heart. In the reality that we know of, however, it is solely an organ that pumps blood. Consistently and relentlessly. Until the day we die. So where, really, has the emotional connection to love come from? No other organ in the human body has this direct interconnection with what is believed to be the most powerful emotion. Most scientists believe that our hearts have very little to do with how we actually feel love. The brain's limbic system and the wide range of chemicals released periodically are the reason behind love. They believe the autonomic nervous system to translate emotion into physical reactions, which could explain the bodily reactions. But this probes a question—why did the heart turn out to be the symbol of emotions, if it really all is because of the brain? Could there be something behind the literature and poetry that is so often appreciated, but never processed? And if so, could science provide an explanation?

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There are some researchers that believe this connection is possible because the human heart has a mind of its own. These connections are not based on theories, but actual scientific experiments.

In order to have a mind, we have to be able to think, and for that, we need neurons.

Why is it that neurons are the only cells capable of dependent thinking? i.e., why can't other cells like erythrocytes think, express, manifest, and communicate this thinking with other cells of their own kind? Wouldn't that, kind of, make their job easier? This is because neurons detect information from the outside world and transmit this information to other nerve cells. This is the fundamental physical basis for how thinking works. Also, there is quite no other cell that can interpret and translate the meaning of a message from the outside world.

In essence, good sleep is foundational to a healthy, balanced life, influencing every aspect of our physical and mental health. Prioritizing quality sleep can lead to improved health, enhanced performance, and a better quality of life.

They can be thought of as the translator implant that Star-Lord used to communicate with the aliens.

The only organ to have neurons, was thought to be the brain, but we now know this is not true.

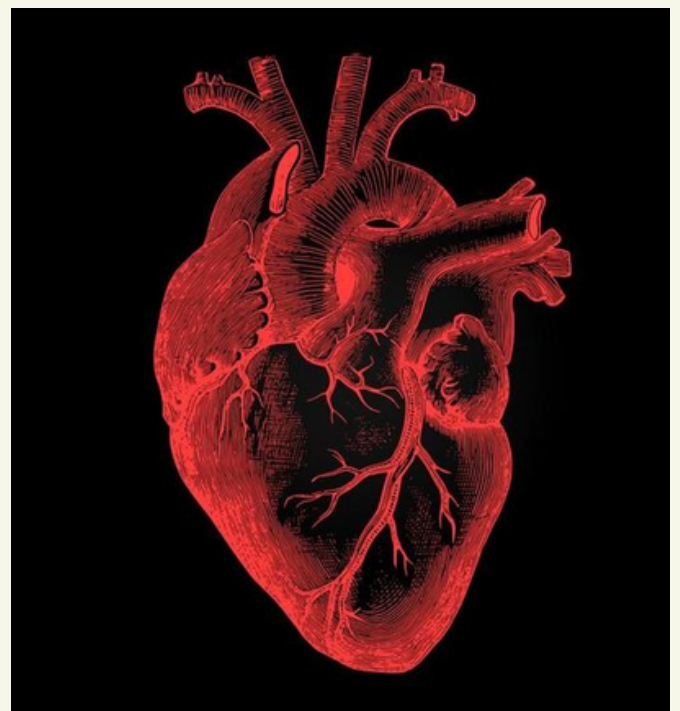
Neurons in your heart —

When we talk about emotions, we all assume that the brain is controlling our emotions. Many scientists, dispute this. They believe that the brain is not the only organ that generates emotions. Why?

The heart accommodates neurons like those in the brain, and these fire in partnership with the brain. The heart and the brain are, therefore, associated with one another.

When your heart receives signals from the brain via the sympathetic nerves, it pumps faster. And when it receives signals through the parasympathetic nerves, it slows down.

Neurons are associated with thought processes in the brain, but highly specialized ones have been found planted on the right ventricle surface. This begs the question, what are thought process neurons doing in an organ that pushes blood around our body?



Neurons in the heart can think for themselves — In an experiment, a piece of right ventricle from a rabbit, where these specialized neurons have been found, is placed in a tank with oxygen and nutrients. The piece of heart manages to beat on its own, despite being unattached, suspended and having no blood flowing through it! When heart tissue is shocked, it immediately slows down this beating.

This is believed to be a direct decision made by the neurons as they respond to the impulse.

The heart reacts actively to negative emotions — Health studies have proved that intense anger has a detrimental effect on the heart, increasing the risk of a heart attack by five times. Intense grief is also extremely unhealthy. You are 21 more times more likely to have a heart attack the day immediately after you have lost a loved one.

Studies have shown that people who have suffered prolonged stressful situations, such as soldiers, combat veterans, doctors, all have higher rates of heart problems than the rest of the population.

In particular, people who have generalized anxiety disorder seem to suffer higher rates of heart attack and other cardiac events. The effect is more pronounced in people who already have a diagnosis of heart disease, and the risk rises with the intensity and frequency of anxiety symptoms.

There are several theories about how constant anxiety of this type may affect the cardiovascular system.

Anxiety disorders can change the body's stress response, the combination of hormonal and physiological reactions that help all animals fight or flee from an actual threat. On an ECG readout, if we are under stress, our heartbeat shows up in a series of jagged and erratic lines. This is called an incoherent heart rhythm pattern. This means that our autonomic nervous system is out of sync with each other.

Scientists equate this to driving a car and having one foot on the gas (the sympathetic nervous system) and the other on the brake (the parasympathetic nervous system) simultaneously.

It also reacts strongly to positive emotions — By contrast, when we experience pleasure, joy or contentment, our heart rhythms become orderly and look like a smooth wave. Scientists call this a coherent heart rhythm pattern where the two branches of the ANS (Autonomic Nervous System) are completely in sync and working together.

Positive emotions, therefore, have some demeanor in our hearts and can actually have healing properties.

Mind over matter, you might think, but which mind and where?

The heart has an effect on your mind — In an experiment conducted in a film by David Malone, he looks at images, some neutral and some frightened.

Some are synced in time to his heartbeat, and others are not. The results revealed that when he saw the frightened images in sync with his heartbeat, he perceived them as being 'more profoundly frightened' than when he saw them out of sync.

his would suggest that his heartbeat is affecting his mind, and processed a greater reaction in connection with the images and the heartbeat. During the test, researchers mapped the exact area of the brain that was affected by the heart, which was the amygdala.

The amygdala is the fight-or-flight network that processes fear reactions alongside signals from the heart.



In this experiment, however, it is the human heart that is affecting the brain in the initial occurrence.

There are many arguments, one of which is: It is our heart working in tandem with our brain that allows us to feel for others... It is ultimately what makes us human... Compassion is the heart's gift to the rational mind."

Of course, though, this is hardly controversial, and there are studies being conducted. As scientific thinkers, strategizing and conducting experiments is key before drawing up conclusions.

Is this just philosophical, poetic thinking?

There are still many scientists that argue having neurons in the heart does not make it "a thinking organ".

There are neurons in the spinal cord and the nervous system, but they do not have minds either. Some scientists believe the reason for neurons in the heart is that it is a highly specialized organ that requires neurons to regulate and process the extreme demands of the cardiovascular system.

The neurons in the brain are not the same as the neurons on the heart, and having neurons present does not prove consciousness. The brain comprises a labyrinthine pattern of neurons, organized in a specialized way that allows us to produce cognitive thought.

The nervous system acts as an antenna, which is tuned to and acknowledges to the electromagnetic fields produced by the hearts of other individuals. The capacity for this exchange of energetic information is an elemental ability that magnifies consciousness and resolves important aspects of genuine empathy and sensitivity to others.

This energetic communication ability can be intentionally enhanced, producing a much deeper level of nonverbal communication, understanding, and connection between people. There is also intriguing evidence that heart field interactions can occur between people and animals.

06 UNDERSTANDING AND ADDRESSING DIGITAL ADDICTION: A COMPREHENSIVE OVERVIEW

~ ANUMEHA PANT
XI - S

Introduction -- In today's digital age, technology's pervasive role has introduced a new form of addiction: digital addiction. This condition involves a harmful dependence on digital media and devices, profoundly impacting individuals' lives. This article explores the nature of digital addiction, its mechanisms, symptoms, impacts, and effective strategies for management and prevention.

Definition and Mechanisms

Digital addiction is marked by a detrimental reliance on digital media and devices that disrupt normal life. The addiction mechanism is closely tied to the brain's reward system. Digital media, especially social media, triggers dopamine (a neurotransmitter) release, similar to addictive substances. This hijacking of the reward circuits contributes to increased digital usage and negative emotional states when users are not interacting with digital content. The addictive nature of smartphones is further amplified by their combination of video games, social media, and instant communication, leading to cravings and inappropriate usage.



Symptoms and Impact

Alexithymia and Depression:

Alexithymia, or difficulty in recognising and describing emotions, positively correlates with higher depression levels. Internet addiction mediates this relationship, with higher alexithymia leading to more internet addiction, which exacerbates depressive symptoms. Physical activity can reduce the impact of internet addiction on depression.

Smartphone Addiction and Well-being:

Smartphone addiction is associated with feelings of loneliness and reduced subjective well-being. Loneliness mediates this relationship, meaning excessive smartphone use can decrease well-being through increased loneliness.

Digital Technology Failures:

Individual differences like Fear of Missing Out (FoMO), internet addiction, and personality traits (e.g., extraversion, neuroticism) predict maladaptive responses to digital technology failures. Traits like agreeableness, conscientiousness, and openness predict more adaptive responses, with age correlating negatively with extreme frustration.

Stress Responses and Internet Addiction:

Individuals with internet addiction show a blunted cortisol response to psychosocial stress but normal sympathetic nervous system responses. They experience higher psychological distress but similar immediate emotional responses to stress compared to non-addicts.

Youth:

Increased screen time correlates with higher rates of ADHD and behavioral problems. Screens can impair brain development, particularly the prefrontal cortex, affecting executive functioning and impulsivity.

Internet Gaming Disorder (IGD)

Internet Gaming Disorder (IGD) is a specific type of digital addiction recognised in the DSM-5 (book by American Psychiatric Association). It involves intense preoccupation with gaming, withdrawal symptoms when not gaming, increased gaming needs, and loss of interest in other activities.

Specific Studies and Findings

1. Smartphone Addiction in Denmark:

- Ownership: 90% of individuals own smartphones, with 93% among 10-year-olds.
- Mental Health: Excessive use correlates with mental health issues: depression (mean score = 48), anxiety (mean score = 50), stress (mean score = 45), and low self-esteem (mean score = 43).
- Physical Health: Smartphone addiction is associated with lower physical activity (mean hours per week = 3) and increased sedentary behavior (mean hours per day = 8).

2. Smartphone Addiction in Italy:

- Prevalence: Ranges from 1.2% to 22.1%, with associations to personality traits like extraversion and social problems.
- Preventive Strategies: Focus on family dynamics and the use of assessment tools like the Smartphone Addiction Scale (SAS).

3. Facebook Addiction and Sleep Problems in Peru:

- Prevalence: Facebook addiction affects 16.2% of students, and 12.5% report sleep problems.
- Associated Factors: Physical activity is linked to lower rates of sleep problems (PR: 0.81, 95% CI: 0.70–0.94) and Facebook addiction (PR: 0.55, 95% CI: 0.33–0.90). Older age is associated with fewer sleep problems (PR: 0.99, 95% CI: 0.98–0.99).

Solutions ---

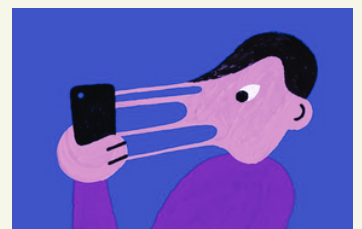
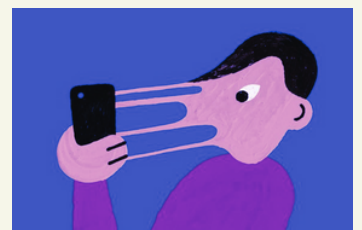
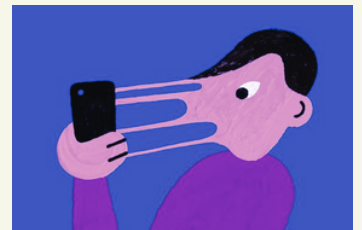
Setting Limits: Establish time limits on screen use, Remove devices at night, Discuss the effects of addiction with children.

Promoting Offline Activities: Encourage participation in sports, music, and community activities, Foster a love of reading

Educational Efforts: Educate about the addictive nature of digital media, Promote offline interactions.

Conclusion ---

Digital addiction represents a growing challenge with significant implications for mental health and societal well-being. Understanding its mechanisms, symptoms, and impacts is essential for developing effective management and prevention strategies. By setting limits, promoting offline activities, and fostering education, individuals and communities can work toward mitigating the effects of digital addiction and enhancing overall well-being.



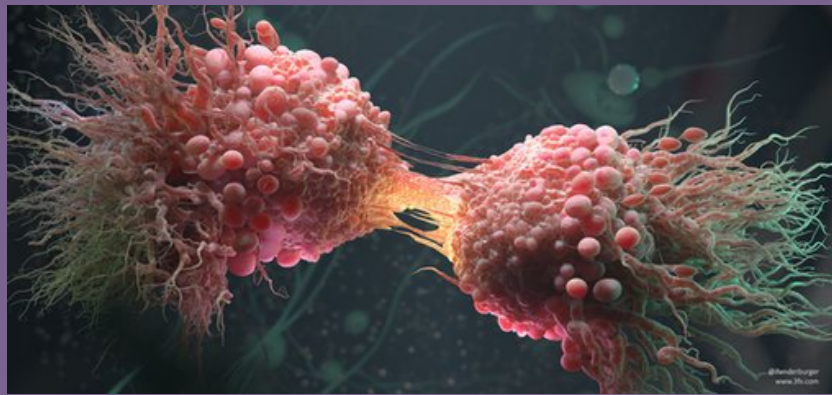
CANCER

-ANUMEHA PANT
XI S

07

What is Cancer?

Cancer is a group of diseases that is characterized by the uncontrolled growth and spread of abnormal cells in the body. When cells grow old or become damaged, they die, and new cells take their place. Sometimes this orderly process breaks down, and abnormal or damaged cells grow and multiply when they shouldn't. These cells may form tumors, which are lumps of tissue. It can start almost anywhere in the body. These tumors can be either benign (non-cancerous) or malignant (cancerous). Malignant tumors can invade nearby tissues and spread to other parts of the body through the bloodstream or lymphatic system, a process known as metastasis.



Most types of cancers have 4 stages, numbered from 1 to 4.

Stage 1 usually means that a cancer is small and contained within the organ it started in

Stage 2 usually means that the tumour is larger than in stage 1 but the cancer hasn't started to spread into the surrounding tissues. Sometimes stage 2 means that cancer cells have spread into lymph nodes close to the tumour. This depends on the particular type of cancer

Stage 3 usually means the cancer is larger. It may have started to spread into surrounding tissues and there are cancer cells in the lymph nodes nearby.

Stage 4 means the cancer has spread from where it started to another body organ. For example, to the liver or lung. This is also called secondary or metastatic cancer

As the stages progress the survival rate reduces.



Diagnosis:

Early detection and treatment are crucial for improving the chances of successful outcomes. Imaging tests used in diagnosing cancer may include a computerized tomography (CT) scan, bone scan, magnetic resonance imaging (MRI), positron emission tomography (PET) scan, ultrasound and X-ray.

Causes:

The true cause of cancer is still unknown. Some say it is evolution of the body. Some say it may be caused due to genetics, environmental, or constitutional characteristics of the individual.

Some of the known causes are:

Genetics, Smoking, Tobacco, Ultraviolet rays, Radiation

Treatments can include –

Surgery, radiation therapy, chemotherapy, targeted therapy, and immunotherapy.

There is a vaccine available to prevent some types of cancers for women:

The cervical cancer vaccine, or the HPV vaccine, protects against the human papilloma virus (HPV), a distinct group of viruses that is spread through sexual contact. HPV is a main cause of cervical cancer and can also contribute to the development of vulvar, vaginal, anal and oropharyngeal cancers.

Types Of Cancer :

There are over 100 different types of cancers. Common types include breast cancer, lung cancer, prostate cancer, and colorectal cancer.

- Carcinoma is a cancer that starts in the skin or the tissues that line other organs.
- Sarcoma is a cancer of connective tissues such as bones, muscles, cartilage, and blood vessels.
- Leukaemia is a cancer of the bone marrow, which creates blood cells.
- Lymphoma and Myeloma are cancers that begin in the cells of the immune system.
- Brain and spinal cord cancers are cancers that are known as central nervous system cancers.

Protection:

Don't smoke, Maintain a healthy weight, Exercise regularly, Eat a healthy diet, Protect yourself from the sun, Protect yourself from infections, Get screening tests regularly.

08 DNA FINGERPRINTING AND EMERGING PHENOTYPING TECHNOLOGIES

– KAYAL, SREELAKSHMI
& SWETHA (XII-P)

DNA FINGERPRINTING -

DNA fingerprinting is a forensic technique that identifies individuals based on unique patterns in their DNA. By analyzing specific regions called Short Tandem Repeats (STRs), DNA profiles are created and compared.

APPLICATIONS –

1. Forensic Science -

- Crime Scene Investigation
- Cold Cases
- Victim Identification



Paternity and Relationship Testing -

- Paternity Tests
- Family Reunification: Confirming biological relationships for legal and immigration purposes.
- Inheritance Disputes

Medical and Genetic Research –

- Disease Research
- Genetic Counselling
- Personalized Medicine: Tailoring medical treatments based on an individual's genetic profile.

Identification –

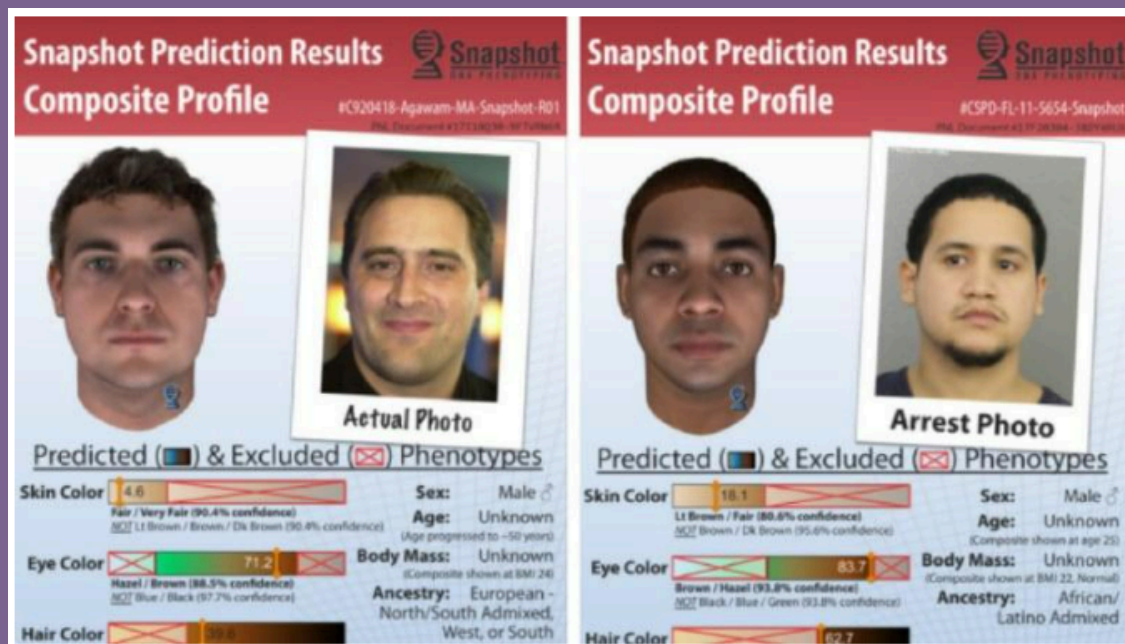
- Missing Persons: Identifying missing persons by comparing DNA with relatives.
- Disaster Victims: Identifying remains in mass disasters (e.g., natural disasters, plane crashes).

Conservation and Wildlife Management –

- Biodiversity Studies: Assessing genetic diversity in animal and plant populations for conservation efforts.
- Poaching Control: Identifying the origin of seized animal products (e.g., ivory, skins) to combat illegal wildlife trade.

Anthropology and Archaeology

- Ancient DNA Analysis: Studying the genetic material from archaeological remains to understand human evolution and migration patterns.



Ethical considerations continue to play a crucial role in guiding stem cell research. The debate over the use of embryonic stem cells has led to the establishment of regulatory frameworks and ethical guidelines aimed at balancing scientific progress with moral concerns. In parallel, the development of iPSCs has provided a promising alternative, but it also raises new questions about the long-term implications of reprogramming adult cells and their potential use in clinical settings.

UPCOMING TECHNOLOGIES – DNA PHENOTYPING

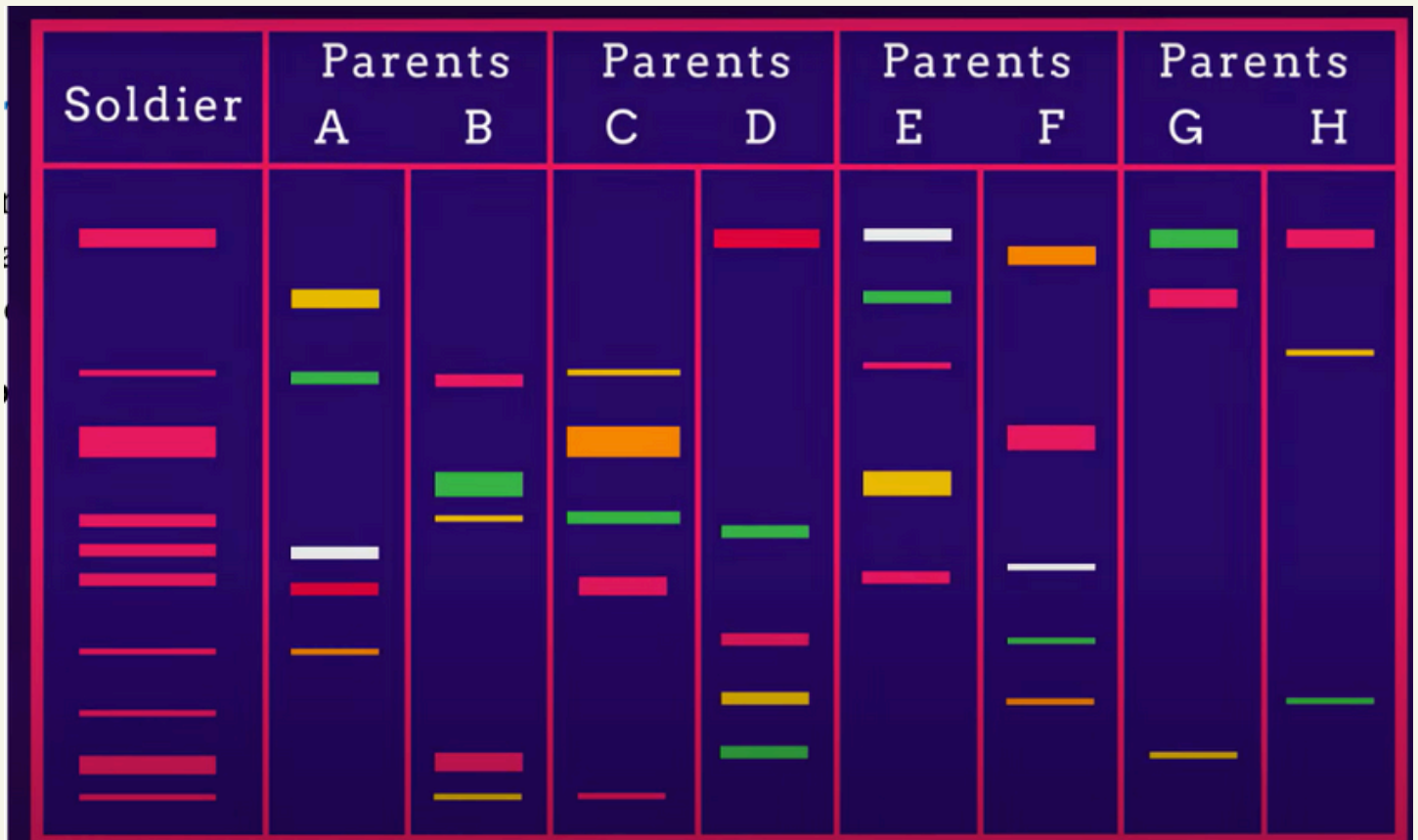
DNA phenotyping is a technique used to predict an individual's physical appearance and ancestry from their genetic information. By analyzing specific genetic markers, scientists can estimate traits like eye color, hair color, skin tone, and facial features, which can be useful in forensic investigations and identifying unknown individuals. It helps in creating composite sketches, solving cold cases, and enhancing missing persons reports. Additionally, it can aid in ancestry research and personal genetic profiling.

The technology is still evolving and is not perfect, as our understanding of the genetic basis for facial features is still incomplete. However, it is a powerful tool that can provide valuable insights, particularly when combined with other methods of identification.

CASE STUDY –

A soldier has been killed in an explosion and has lost his dog tags that identify him. Three soldiers are missing from their unit so the army asks the three sets of parents for a DNA sample so they might compare it to the soldier's DNA and therefore make an identification.

Remember the soldier will only share half of his DNA with each parent.



Parent C and D as you can see he inherited the first band from parent D and the second, third and fourth from parent C and so on.



SCIENCE BULLETIN



NEET 2024

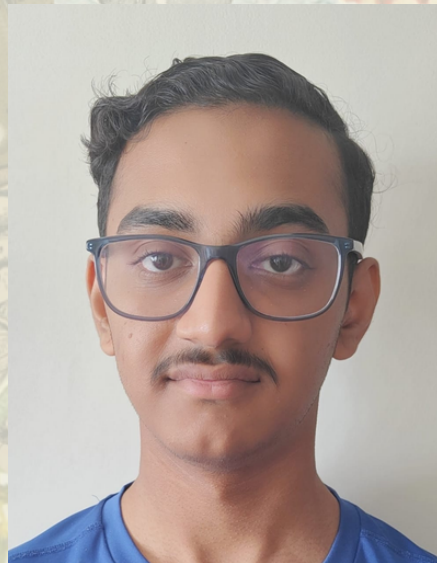
ALL INDIA RANK ACHIEVERS



Rahul K
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Nikhil Devisetty
Rank - 81270
College - Vydehi Institute of medical sciences and research Center



Name: Koyalman Abhishek Arun
Marks: 680/720
Rank: 7505
College: Lokmanya Tilak Municipal Medical College, Mumbai

KAMP NASTA



KAMP-NASTA 2023 (National Assessment for Scientific Temperament & Aptitude, organised by Knowledge and Awareness Mapping Platform (KAMP) an initiative of CSIR-NIScPR, Under DSIR, Govt. of India) was conducted on 7th Dec 2023.

Our students have performed exceedingly well. ISHAAN of grade 8 R has secured State Rank 1 in class 7 category and ANGSHU RAY of Grade 9 A has secured State Rank 1 in class 8 category.

We extend our heartfelt congratulations for their outstanding performance. Best Wishes for the National Level Test.

SCIENCE WEEK

2024-25

Date: July 30, 2024 **Location:** Delhi Public School Bangalore East

Introduction

On July 30, 2024, We Delhi Public School Bangalore East hosted an exciting Science Quiz for students in grades 11 and 12. The primary goal of the event was to foster a deeper interest in science, enhance knowledge across various scientific disciplines, and encourage healthy competition among students.

Objective

The Science Quiz aimed to:

1. Promote interest in scientific inquiry and discovery.
2. Assess and expand students' understanding of scientific concepts.
3. Encourage teamwork and intellectual engagement among students.

Participants

The quiz saw enthusiastic participation from all sections of class XI and XII. The teams were categorized by houses in each section.

Quiz Structure

It was conducted in two levels

Level 1:

Open to all four teams

40 questions across 4 categories:

1. Know Your Science (3 rounds)
2. Our Great Scientists (2 rounds)
3. Identify Me (4 rounds)
4. All About Laws (1 round)

Direct questions: 10 marks each

Passing questions: 5 marks each

Level 2 (Rapid Fire):

Top 2 scorers from Level 1 participate
15 questions per team, asked one after the other
Each question: 1 mark

Highlights

- ▣ **Expert Panel:** The quiz featured a panel of esteemed class teachers who crafted the questions and evaluated the answers.
- ▣ **Interactive Elements:** The quiz included interactive segments.

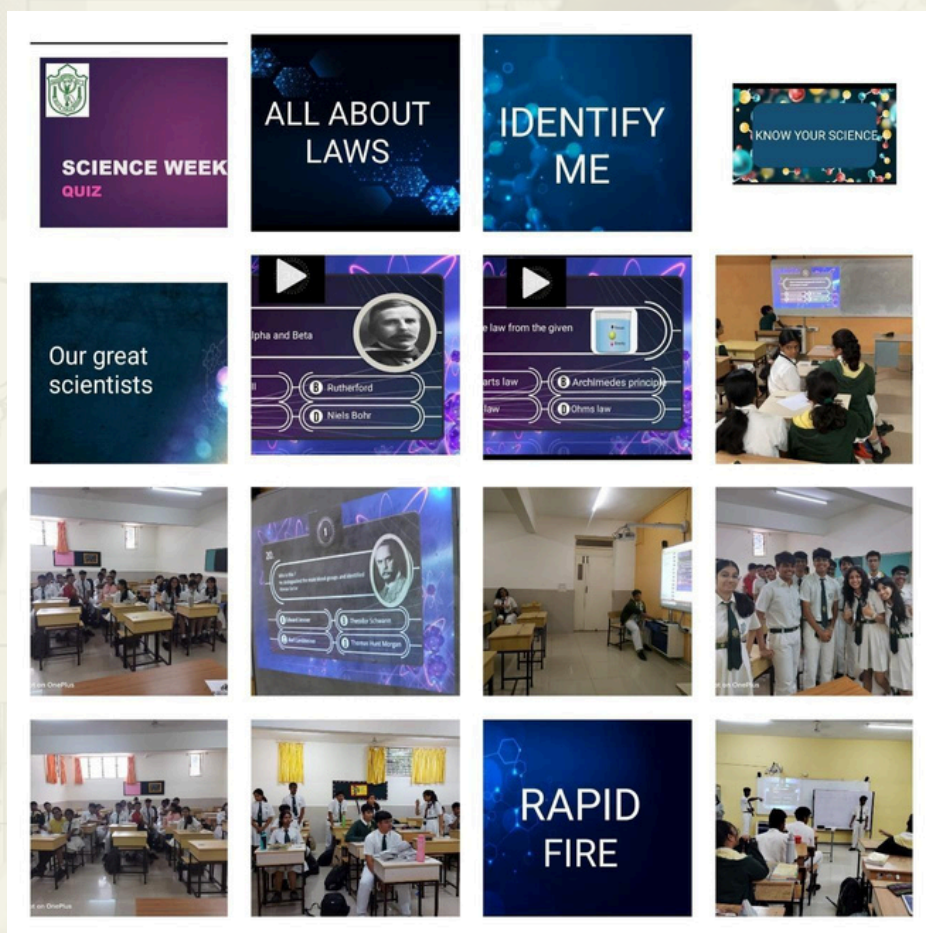
Feedback

The feedback from participants, teachers was overwhelmingly positive. Students appreciated the challenging questions and the opportunity to showcase their knowledge.

Teachers noted the event's success in stimulating interest in science and encouraging collaborative learning.

Conclusion

The Science Quiz was a resounding success, meeting its objectives of promoting scientific curiosity and knowledge. The event not only highlighted the students' academic prowess but also reinforced the value of teamwork and critical thinking.









CREW



PHYSICS DEPARTMENT



(Left to Right)

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- 2. Mr. Murthy Kancharla**
- 3. Ms. Inderpreet Kaur**
- 4. Ms. Kruthi. R**
- 5. Ms. S Aparna Raju**
- 6. Ms. Monika Sharma**
- 7. Ms. Raghy Nair**
- 8. Ms. Shabana Shagul**
- 9. Mr. Joseph Sagayaraj K G**



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Thank you for reading the Third
edition of

SCIENTIA

VOL 3

2024

Delhi Public School Bangalore East

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