

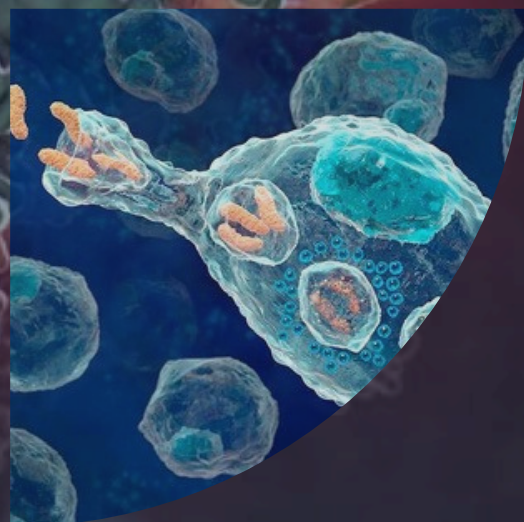
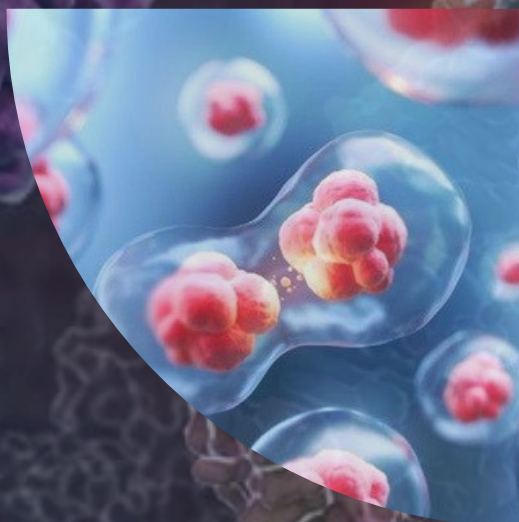
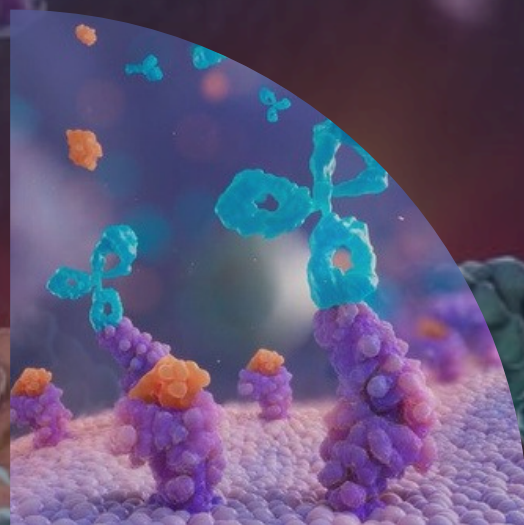
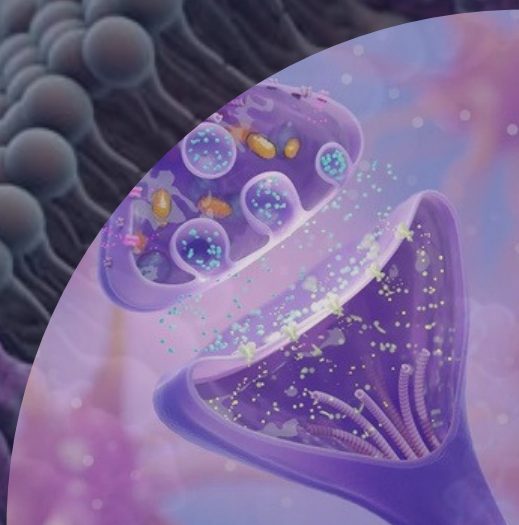


5th Edition

JIVANAM

Unveiling Life's Blueprint

PHYSIOLOGICAL BIOCHEMISTRY
FROM CELLULAR FUNCTION TO CELLULAR FALLOUT



MINDS BEHIND JIVANAM 5.0



Pearl Patel



Patel Prathmesh



Krish Jadeja



Patel Nitya



Rani Chavda



Tathya Yagnik

MINDS BEHIND JIVANAM 5.0



Harsh Pandya



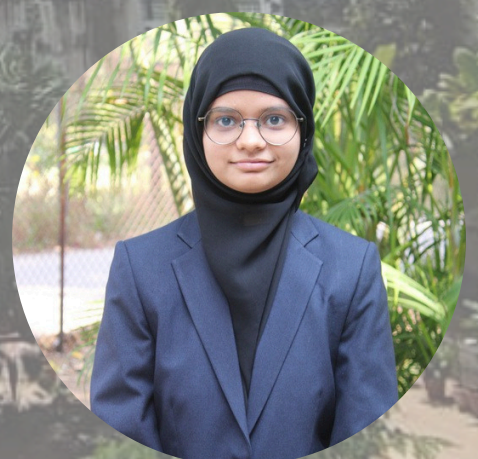
Ayush Baluni



Tirth Raval



Masuma Shaikh



Humaira Khan



Abhiraj Parmar

Principal Desk



Dear Students of the Biochemistry Department, It gives feeling of proud and pleasure because, the students of Biochemistry department preparing to bring out the 5th Edition of Jivanam a magazine from Biochemistry Department. This shows the enthusiasm, creativity, and collective effort of the students who have contributed to its journey over the years.

I believe that Jivanam reflects the powerful minds of upcoming young scientists and blends science and creativity, capturing the essence of life through the lens of Biochemistry. On the occasion 5th Edition, it clear shows student's showcase your academic insights, innovative ideas, artistic talents, and departmental achievements. I appreciate overall dedication and teamwork in carrying forward this legacy which will be carried out the values of originality, quality, and collaboration in the upcoming years. I also appreciate the staff members of the department who have given students responsibilities showing tremendous trust in the students. May this edition of Jivanam inspire curiosity, foster learning, and leave a lasting impression on its readers. I wish all every success in making the 5th Edition of Jivanam a meaningful and memorable publication.

Best Wishes,

Dr. Jatin Parikh

Offg. Principal

Vice-Principal Desk



It is a matter of great happiness to see the Department of Biochemistry launch its magazine, '**Jivanam**'. A publication like this is never the result of a single effort. It comes from many discussions, careful editing, creative thinking, and the willingness to go the extra mile beyond routine academic work. *Jivanam* beautifully reflects the enthusiasm, ideas, and scientific spirit that the department nurtures. I would especially like to appreciate the dedicated efforts of the **editorial team** and all the **student and faculty contributors**. The time, patience, and teamwork invested behind the scenes have truly brought this magazine to life, and such sincere efforts deserve special recognition. I congratulate the Head of the Department, faculty members, the editorial team, and every contributor for this wonderful initiative. I am confident that *Jivanam* will inspire many young minds and grow into a valued tradition of the department. My best wishes for the continued success of *Jivanam*.

Warm regards,

Dr Noopur Goyal

Vice Principal M.G. Science Institute,
Ahmedabad

From The Faculty Desk



It is with immense pleasure and pride that we welcome you to the **fifth edition of Biochemistry Department's e-magazine, JIVANAM.**

This publication beautifully reflects the academic enthusiasm, creativity and scientific spirit that thrive within our students. The magazine serves as a powerful and inspiring platform for students to showcase their talents, creativity and intellectual curiosity which goes beyond the curriculum, encouraging communication and teamwork, all of which are vital in the scientific world. It provides a space where hidden potential is discovered, nurtured and celebrated, allowing students to express ideas that can inform, inspire and benefit a wider audience. More than just a publication, it plays a vital role in encouraging innovation, critical thinking and collaboration among young minds. Every page reflects their commitment to excellence and their passion for learning and expression.

We sincerely appreciate the dedication and hard work of the editorial team and all student contributors who have made this edition possible. Their commitment reflects the importance of knowledge-sharing and leadership, much like the exchange of information within a living cell that ensures growth and continuity.

We extend our heartfelt best wishes to the editorial team, students who have contributed for the magazine & all the other students for a future filled with discovery, innovation and purpose.

With warm wishes for continued learning and success.

Faculty Team

Prof. Sunita Jha

Dr. Vijaya R. Nadagouda

Dr. Ajit V. Pandya

Dr. Kirtikumari D. Patel

Prof. Dipali Sharma

Warm Wishes



Wishing the institute and the Department of Biochemistry continued success in shaping bright minds and futures. My time here was transformative, filled with important lessons from incredible teachers and the support of wonderful classmates. Their guidance and encouragement helped me believe in myself, and I'm still reaping the benefits of that foundation. I'm especially thankful to my teachers Dr. HV Pandya, Mrs DT Chokshi, Mrs SV Jha, and Dr. VR Nadagauda for their unwavering support and hope that new students experience the same growth, inspiration, and opportunities.

Yogendra Raol, Class of 1993 (Biochemistry Department)

Program officer

National Institutes of Health, USA

JOURNEY OF BIOCHEMISTRY DEPARTMENT

We started an undergraduate programme in Biochemistry in the academic year 1991-92 with a batch of forty five students. The department became functionally active from 12th July 1991 with two faculties and two laboratory staff. Two more faculties joined in September 1992. The journey of the department has been a collective experience of learning and growth shaped by the dedication of faculty and the enthusiasm of students. Together an academic environment was created that encourages knowledge, discipline and excellence.

We started the department with one empty laboratory and today we have two well equipped laboratories and classrooms with smart boards which has helped in the academic growth of the department. The collaborative engagement and collective efforts of faculty and motivated students has fostered a strong foundation in teaching, research and innovation.

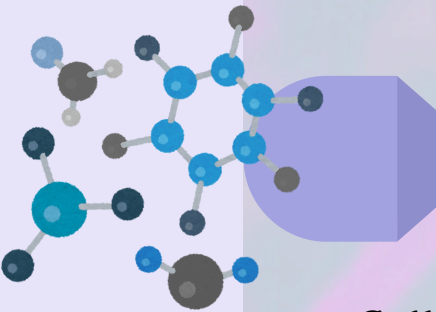
In 1996 the department was involved in establishing a UGC supported programme in Vocational Biotechnology. We designed the syllabus and created necessary infrastructure for the same. We successfully ran the programme till 2021. The department had two research projects (SciTech) supported by Gujarat Council On Science and Technology (GUJCOST) and one minor project by UGC.

In 2013 the department organized a national conference on “Biochemistry: A science beyond Compartmentalization.” This conference was supported by UGC and GUJCOST. Nearly 200 participants were registered for the same. In 2015 the department organized an International conference on “Recent advances in Biological sciences.” There were nearly 375 participants in this conference. This reflects the department’s steady pursuit towards scientific excellence.

The department has conducted several workshops, seminars and hands on training programmes for the students. These workshops and seminars were aimed to bring a collaboration between theory and laboratory based learning. It also plays a vital role in shaping a productive and intellectually stimulating academic environment. It also contributed to the college NAAC accreditation which was securing ‘A’ grade two times. Majority of our alumni are settled well in India as well as abroad. They support our department and make it a point to visit their alma mater when possible. To mention few, Dr. Yogendrasinh Raol, Dr. Meghna Patel, Dr. Amit Thakkar, Dr. Harsh Amin, Dr. Munjal Acharya (Associate Professor UC Irvine California USA),

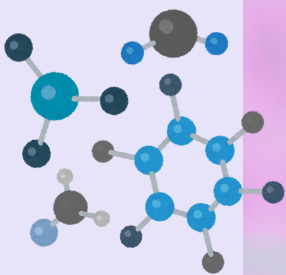
Dr.Charnitkaur Jashal (Senior Manager Cell and gene therapy Intas Pharmaceutical), Sarang Gohil (Assistant Manager QMS at Vaccine Technology Center Zydus Group), Himashree (Capgemini Business Transformation Consultant), Devang Vaidya (Awarded with Global Top Talent 2020-2021).

Our department believes not just academics but to inculcate in students a holistic personality development and so supports study tours, internships, industrial/ research laboratory visits, sensitivity towards environment and value based education. The department's journey reflects strong bond between faculty and students, built on learning, co-operation and mentorship. This shared path has nurtured academic excellence and inspired continuous growth. We are grateful and appreciate the student's endeavor to make Jivanam an annual event and look forward to the continuation for the same for years to come.



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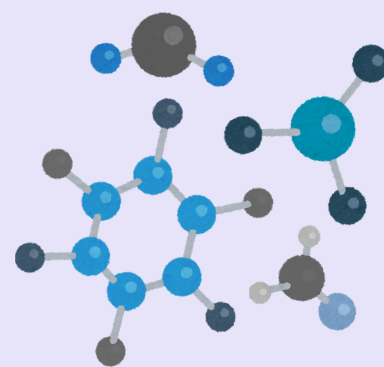
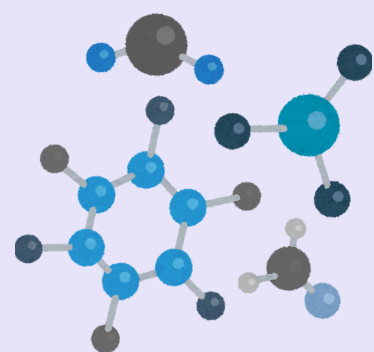
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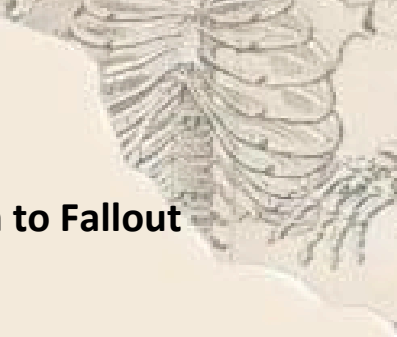


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Jivannam – 5.0





Cellular Destiny: The Biochemical Journey from Function to Fallout

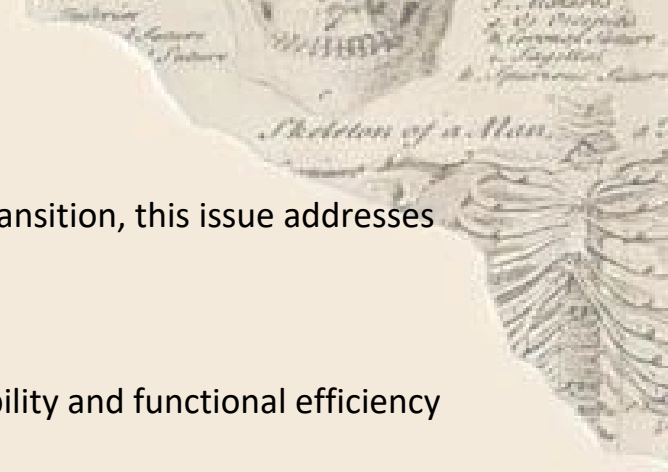
Life, at its most fundamental level, unfolds within the boundaries of a cell. Every breath we take, every thought we form, and every movement we make is supported by countless biochemical events occurring silently within microscopic units of life. Cells are not merely structural components; they are dynamic systems, guided by intricate molecular pathways that determine health, adaptation, and survival.

This issue of Jivanam explores cellular destiny—the journey from precise biological function to potential biochemical failure. When cellular processes operate in balance, life thrives. Enzymes perform with accuracy, signaling pathways communicate efficiently, and homeostasis is maintained. However, when this balance is disrupted—through genetic mutations, environmental stress, nutritional deficiencies, or metabolic overload—the same pathways that sustain life can contribute to disease and degeneration. This gradual shift from function to fallout forms the biochemical basis of many modern health challenges.

By understanding cellular mechanisms, we gain insight not only into disease, but also into prevention, resilience, and responsibility. Advances in biochemistry and molecular biology have revealed how small cellular changes can lead to large-scale physiological consequences. This knowledge empowers future scientists, healthcare professionals, and informed citizens to think critically about health, lifestyle, and innovation.

Cellular Destiny invites readers to look beyond symptoms and systems, and instead focus on the cell as the starting point of life's story. Through this theme, Jivanam aims to foster curiosity, awareness, and appreciation for the silent biochemical forces that shape our present—and determine our future.

Through this theme, Jivanam seeks to cultivate awareness, curiosity, and thoughtful engagement with the science of life. By examining the cell as both a source of resilience and vulnerability, this issue encourages readers to appreciate the delicate balance that sustains living systems. In recognizing cellular destiny, we begin to understand our own role in shaping the future of health, science, and society.



To provide a structured understanding of this transition, this issue addresses the following key themes

Cellular regulation and homeostasis

The biochemical mechanisms that preserve stability and functional efficiency within cells.

Adaptive responses and pathological shifts

The gradual transformation of protective cellular responses into sources of dysfunction.

- Advances in biochemical and molecular research

How emerging technologies contribute to improve diagnosis, therapeutic precision, and prevention.

Scientific responsibility and sustainability The impact of environmental, lifestyle, and ethical considerations on cellular health.

Cellular foundations of disease

The role of molecular and biochemical alterations in the early development of disease. Collectively, these perspectives emphasize the interconnected nature of cellular processes and their broader biological implications.

Cellular destiny is not a fixed outcome, but a dynamic process influenced by regulatory precision and external conditions.

Otto Heinrich Warburg: Pioneer of Cell Metabolism and Oncology

Otto Heinrich Warburg (1883–1970) was a towering figure in German biochemistry, a Nobel laureate whose interdisciplinary research bridged chemistry, medicine, and physics to fundamentally advance the understanding of cellular respiration and cancer metabolism.

Early Life and Academic Foundations

Born in Freiburg, Baden, in 1883, Warburg was the son of the renowned physicist Emil Warburg. This early exposure to physics deeply influenced his quantitative, rigorous approach to biological questions. He pursued a dual academic track, first studying chemistry under Emil Fischer and earning a Doctor of Chemistry (Berlin) in 1906. He then studied medicine under von Krehl, obtaining a Doctor of Medicine (Heidelberg) in 1911. This dual expertise provided the perfect foundation for his subsequent work in biochemistry.

Between 1908 and 1914, Warburg was affiliated with the Naples Marine Biological Station. During this period, he conducted seminal research on the consumption of oxygen in sea urchin eggs, demonstrating a sixfold increase in the rate of respiration upon fertilization and showing that iron was essential for larval development.

World War I and Academic Ascent

Warburg served as an officer in the elite Prussian Horse Guards (Uhlans cavalry) during World War I, where he won the Iron Cross. He later credited this military service with providing him valuable insights into life outside academia. Toward the end of the war, physicist Albert Einstein, a friend of Warburg's father, urged him to leave the army and return to science, recognizing the potential tragedy of losing his talents. Einstein and Warburg later became friends, with the former's work profoundly influencing Warburg's scientific methodology.

Upon returning to civilian life, Warburg rapidly rose through the ranks. In 1918, he was appointed Professor at the Kaiser Wilhelm Institute for Biology. By 1931, he was named Director of the Kaiser Wilhelm Institute for Cell Physiology, an institute specifically founded for him through a donation from the Rockefeller Foundation.

Nobel Prize and Scientific Contributions

In 1931, Warburg was awarded the Nobel Prize in Physiology or Medicine for his "discovery of the nature and mode of action of the respiratory enzyme." This work identified the critical enzyme responsible for oxygen utilization in cellular respiration. A key finding that factored into his award was his observation that

Hypothesis

- Warburg hypothesis
- Warburg effect (oncology)
- Warburg effect (plant physiology)
- Warburg-Christian method

General information & Academics

- Born:-8 October 1883
- Freiburg, Baden, German Empire
- Died 1 August 1970 (aged 86)
- Berlin, West Germany
- Education
- University of Berlin
- University of Heidelberg Known for Oncometabolism



animal tumours produce large quantities of lactic acid—an observation that formed the basis of his cancer hypothesis.

Warburg's laboratory was a nexus for talent. Future Nobel laureates George Wald (who discovered vitamin A in the retina while with Warburg) and Sir Hans Adolf Krebs (who identified the citric acid cycle) both worked in his institute. His later work included significant contributions to plant physiology, such as research on the quantum yield of photosynthesis.

The Warburg Hypothesis

Warburg's most famous and debated contribution is the Warburg Hypothesis, which proposed a single, unified cause for cancer:

The prime cause of cancer is the replacement of the respiration of oxygen in normal body cells by a fermentation of sugar.

He argued that cancer growth is caused by tumour cells generating energy primarily through glycolysis (fermentation)—even when oxygen is available—in contrast to healthy cells which rely on the oxidative breakdown of pyruvate in the mitochondria. Warburg concluded that cancer should be interpreted as a form of mitochondrial dysfunction.

While the phenomenon, known as the Warburg Effect (aerobic glycolysis), is a recognized metabolic hallmark of cancer, modern oncology views it as a result of underlying genetic mutations (in oncogenes and tumour suppressors), rather than the prime cause Warburg proposed. Nevertheless, his hypothesis catalysed the entire field of cancer metabolism, which remains a critical and complex area of research today.

Warburg's combined work across plant physiology, cell biology, and oncology made him a key foundational figure in the development of modern systems biology.

Debunking Myths: The Science Behind Sunscreen & Skin Protection

Author - Masuma Shaikh

Department Of Biochemistry Semester 1 Student

Introduction:

Trust the science, not the myths - don't let myths deter you from protecting your skin! Sunscreen is among the most frequently recommended yet often misunderstood products in the field of medicine. While dermatologists largely talk about its advantages, doubts regarding its safety and ingredients it is often mistaken due to online misinformation. There are assertions that sunscreen is ineffective and it could be dangerous. Some authors even go so far as to claim that sunscreen might lead to skin cancer! However, the truth is that sunscreen aims to shield your skin from the harmful rays of the sun. "Research has consistently demonstrated that the regular use of sunscreen decreases the risk of skin cancer and mitigates the signs of aging," according to Susan Swetter, a dermatologist in Palo Alto, California, USA.

How Harmful Is UV Light?

Despite providing warmth and energy, the sun's rays contain UV radiation that can damage skin cells.

UV light components:

1. **UVA rays: (320-400 nm):** Have a longer wavelength, penetrate deeper into the skin, generate oxidative stress and inflammation. It also contributes to wrinkles, uneven skin tone, and skin cancer.

2. **UVB rays: (290-320 nm):** Primary cause of sunburn and plays a key role in skin cancer development and can cause direct DNA damage which leads to mutations and skin cancer like Melanoma.

Biochemical and Physiological Aspects - How Sunscreen Protects Us From UV Light?

→ Skin's natural defences: Melanin production protects against UV radiation.

→ Sunscreen benefits:

- Enhances protection beyond skin's natural mechanisms.
- Prevents UV-induced changes like premature aging, DNA mutation, skin cancer.

⇒ UV Radiation

└─ UVB: Direct DNA damage (pyrimidine dimers, CPDs, (6-4) photoproducts)

↓
Mutations if not repaired (NER)

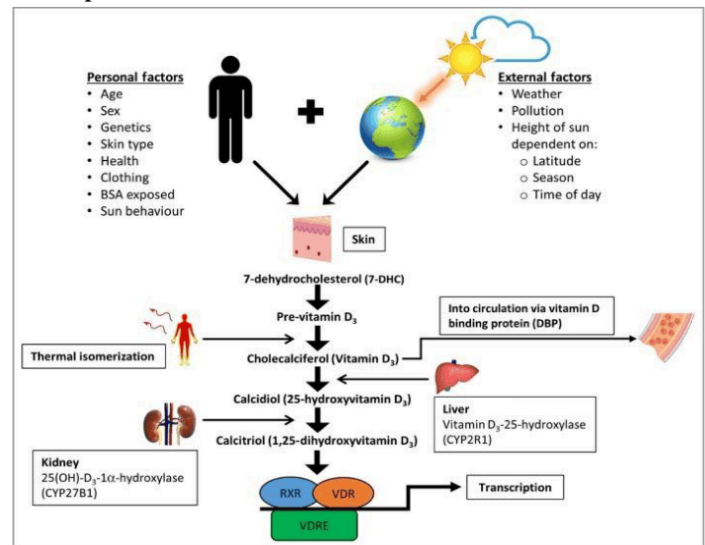
└─ UVA: Oxidative stress (via ROS)

↓

Damage to DNA (8-oxoguanine), proteins, lipids; collagen degradation

∴ Sunscreen → Prevents DNA damage, reduces oxidative stress, enhances protection.

No Impact on Vitamin D!



Choosing The Right Sunscreen - Physical Vs Chemical!

FACTORS	CONSIDERATIONS
Good UV protection	Select broad-spectrum sunscreen which includes physical blockers (zinc oxide, titanium dioxide) or chemical absorbers (avobenzone).
Physical Sunscreen	Reflect UV rays, less likely to irritate. (TiO ₂) and (ZnO).
Chemical Sunscreen	Absorb UV rays and emit heat from the body. (Avobenzone, Octinoxate, Octocrylene, Homosalate) .
Factors for sunscreen selection	Skin type Activity level Environment Sun exposure
Tropical/high-altitude	Need high SPF broad-spectrum sunscreen
Skin type/colour	Darker skin has more inherent protection, but sunscreen helps everyone prevent harm and skin cancer.
Sunscreen selection	Tailored to an individual's lifestyle, surroundings and skin type.

Harnessing Nature for Sun Protection | Exploring Natural UV Safeguards in Sunscreens:

Recent research highlights the potential of natural ingredients like plant and algal extracts (carotenoids, flavonoids) in sunscreens for UV protection and antioxidant benefits.

→ Key Findings:

- Flavonoids & carotenoids in microalgae absorb UV light and offer antioxidant benefits.
- Phenylpropanoid pathways in plants are of scientific interest.
- Rutin and quercetin are notable flavonoids for photoprotection.
- Natural compounds like rosmarinic acid, lignin can increase SPF and scavenge free radicals.
- Phytocosmetics from tea, lutein, fern, lycopene, carrot, and raspberry seed oil show promise with mineral-based zinc oxide.

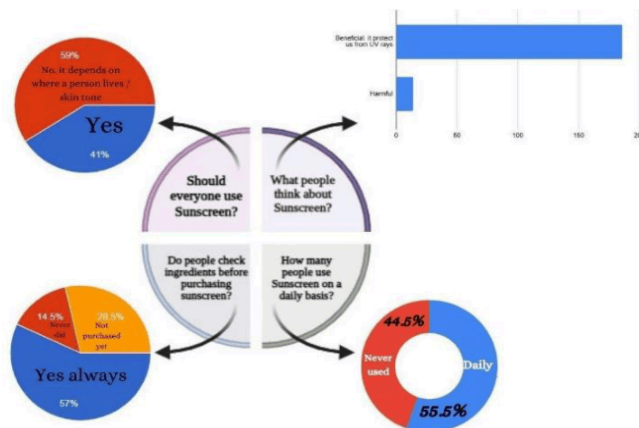
→ Natural Sunscreen Ingredients:

- Microalgae like *Spirulina platensis* absorb UV rays.
- Certain polysaccharides offer UV protection and reduce reactive oxygen species (ROS).
- Fructan from white garlic protects keratinocytes against UVB damage.

→ Thus, using natural substances in sunscreens is gaining attraction for UV protection and antioxidant benefits.

Bridging the Gap Between Perception and Science!

To better understand public attitudes toward sunscreen, a comprehensive survey was conducted among 200 individuals by me, including students and professionals from diverse backgrounds. The results painted a nuanced picture of awareness, usage, and misconceptions. While 93% (186 people) said sunscreen is good, only 55.5% use it daily and 44.5% had never used it at all. This shows that belief doesn't always lead to action, possibly due to lack of access, cultural habits, or myths. Interestingly, 59% of respondents felt that sunscreen usage should depend on variables like geographic location and skin tone, implying that not everyone needs it. This belief reflects a partial understanding of UV exposure risks, which can affect all skin types regardless of region. On a positive note, 114 people check ingredients before buying sunscreen, showing growing awareness. Most said they would use sunscreen if a dermatologist recommended it, proving trust in expert advice. Still, 58% admitted they don't know much about how sunscreen works but want to learn.



Conclusion:

This article, therefore, aims to address that curiosity by debunking common myths, such as the false belief that sunscreen causes cancer or interferes with vitamin D production and by explaining the science behind how different formulations protect the skin. Ultimately, the goal is to empower readers with accurate, evidence-based information so they can make informed decisions about sun protection and skin health.

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Circadian Rhythms:- Reason for Irregular sleep cycle

Author ~ Hetvi Mehta

Department of Biochemistry Semester I Student

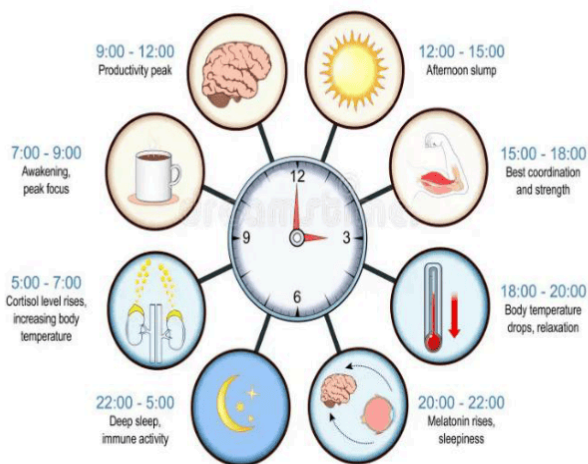
Overview of Cardiac Rhythms:

The daily light-dark cycle governs rhythmic changes in behavior & physiology of most species. Studies have found that changes are governed by the biological clock. Studies have found that the internal clock consists of an array of genes and protein products they encode, which regulate various physiological processes throughout the body. Disruptions of biological rhythms can impair health & well-being of organisms.

What are Circadian Rhythms?

It is a natural, internal biological clock that operates on a 24-hour cycle. This rhythm is a master regulator of sleep and influences other bodily functions. It majorly controls sleep, alertness & acts as the body's master clock. While chronobiology is the scientific study of the biological rhythms profoundly influenced by internal clocks and external environment cues.

Circadian rhythms



Historical overview of Chronobiology:

The mechanisms underlying the biological timekeeping systems and the potential consequences of the failure are among the issues addressed by researchers in the field of chronobiology. Researchers began studying biological rhythms approximately 50 years ago. Although no single experiment shows the defining event that dates the beginning of modern research in chronobiology, studies conducted in the 1950s on these rhythms in fruit flies by Colin Pittendrigh and in humans by Jürgen Aschoff can be considered its foundation.

Recent Insights & Discoveries:

1. "Social Jet Lag" and the Monday Blues

Neuroscientist Dr. Wendy Suzuki of NYU has shed light on why many feel groggy on Monday mornings. Her research reveals that irregular sleep patterns like staying up late on weekends produce effects akin to jet lag. That groggy, sluggish feeling you drag into Monday morning may not just be the case "Monday blues". Research indicates that inconsistent sleep schedules elevate the risk of metabolic disorders. As Dr. Suzuki puts it, "Your brain loves consistency."

2. "Internal Jet Lag" and Mental Health

Researchers at University of Sydney identified a form of circadian misalignment-internal jet lag- in young individuals with mental health concerns. In about 23% of patients aged 16-35, key markers such as melatonin, cortisol & body temperature were out of sync, potentially contributing to mood disorders like depression & bipolar disorder.

3. Modern Sleep Trends vs. Circadian Misalignment

A cross-national analysis found people in industrialized societies tend to sleep longer (about 7.1 hours vs. 6.4 in non-industrialized regions) with greater efficiency. Paradoxically, they also suffer more from circadian misalignment, contributing to health concerns such as cancer & mental illness.

4. Late Breakfast and Longevity

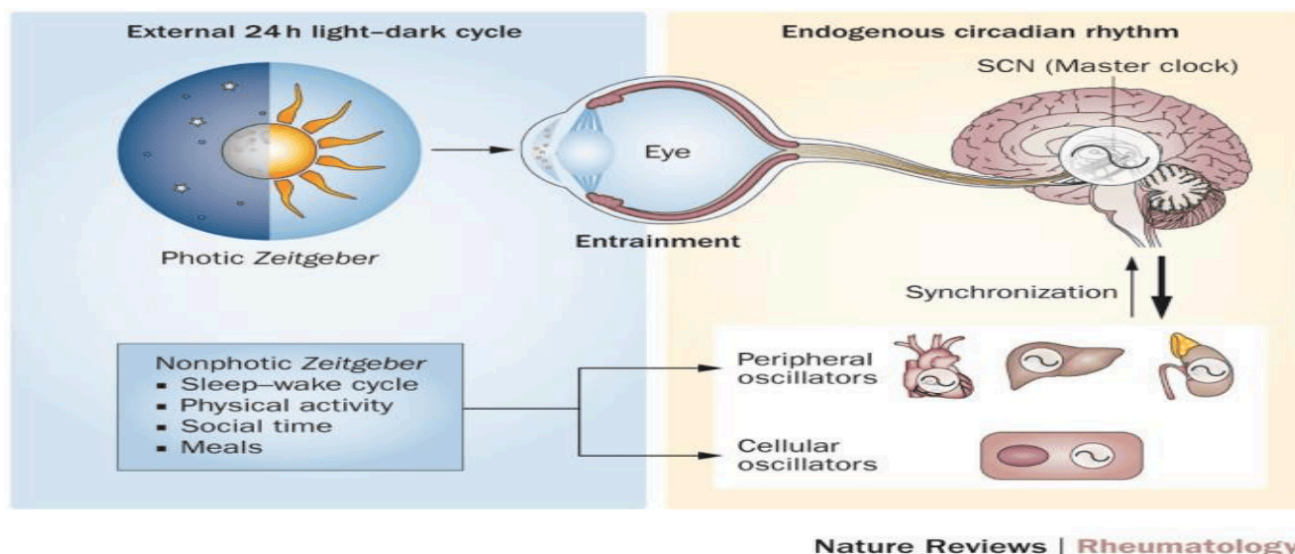
A study from Harvard Medical School led by Dr. Hassan Dashti analyzed nearly 3,000 UK Adults (avg. age 64). Findings show that delaying breakfast by each hour corresponds to 10% increase in mortality risk over a 10-year span. The study proposes that meal timing may serve as an early health indicator.

5. Circadian Syndrome and Early Mortality

New data from China and the U.S revealed a syndrome dubbed Circadian Syndrome (CircS)-a cluster of risk factors including poor sleep, cardiovascular markers. Individuals exhibiting CircS faced significantly higher mortality from conditions like heart disease & cancer.

The Automatic Organization of The Internal Clock:

Although studies tell that in mammals the circadian clock resides in two clusters of nerve cells called the suprachiasmatic nuclei (SCN). It is a bilateral structure located in the region of the base of the brain called the anterior hypothalamus.



Importance of Cardian Clock from Modern as well as Biological Aspects:

1. *Internal Synchronization* - It refers to the coordination of different internal biological rhythms with each other.

2. *Gene Expression* - Circadian rhythms regulate gene expression through a complex network of "clock genes" that form a self-sustaining transcriptional-translational feedback loop.

3. *Energy & Metabolism* - The physiological process in which we use energy such as eat, restore and optimize usage of energy.

Modern Aspects:

1. *Cancer Risk* -Studies link circadian disruption to an increased risk of breast, prostate, lung, ovarian, & liver cancers.

2. *Modern lifestyle* - Key disruptive aspects include the 24/7 availability of electronic devices, which expose people to blue light late at night, causing mental health problems.

3. *Shift work* - is a work schedule that is performed in rotations and for extended hours, leading to health issues.

Latest Research:

Muscle Clocks and Metabolic Disease: In April 2025, Northwestern Medicine researchers led by Clara Peek, found that disrupted muscle circadian rhythms combined with a poor diet can lead to glucose intolerance and diabetes.

Conclusion:

As we are facing the problems in our daily life regarding sleep, poor meal timing, due to fast and modern life that strongly affect health. Scientists are now using their knowledge to design better treatments, such as chronotherapy to restore rhythm.

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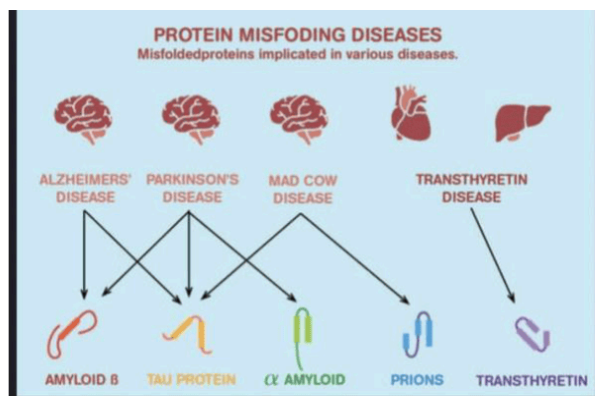
Protein Misfolding - A cellular crisis

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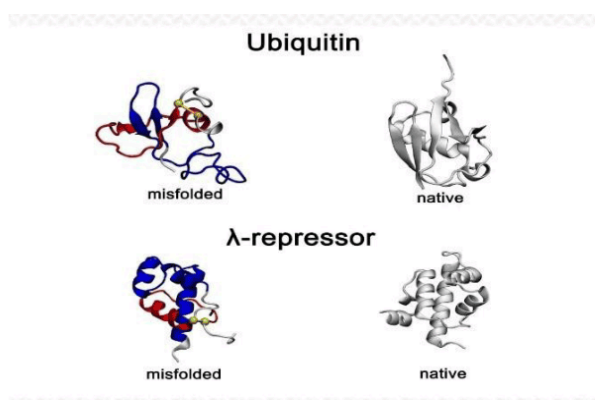
Introduction:

Millions of people in the world suffer from neurodegenerative diseases. Numerous diseases like Parkinson's disease, Alzheimer's disease, cystic fibrosis and many more and misfolding of a protein are believed to be a primary cause for such diseases.



What exactly is protein misfolding?

Basically, a protein has three-dimensional quaternary structure consisting of many complex folding and a small change in these folding results in change of the structure leading to protein misfolding. Research on protein misfolding suggests that it can occur due to several reasons like somatic mutation in gene sequence leading to formation of a different which is unable to fold natively. Another reason could be errors in the process of translation or transcription leading to production of modified proteins which are not able to fold properly.



Can environmental factors affect protein folding?

Cells have a highly organised protein quality control system (PQCs), which maintain the conformation state of cellular proteins. Recent studies suggests that the environmental toxicants such as pesticides, air pollutants and heavy metals may disturb the PQCs network which may lead to protein misfolding.

Chaperones: The key factor

Chaperones are groups of proteins that can prevent non-specific aggregation by binding to non-native proteins, and they also assist in protein folding.

Without chaperones, newly synthesised proteins would become tangled, disturbing cellular processes. Chemical chaperones are used to treat metabolic disease. For example, accumulation of unfolded or misfolded proteins can cause stress to Endoplasmic Reticulum (ER Stress). To relieve this stress, small chemical chaperones are used to promote proper protein folding. Such processes became extremely useful to treat metabolic disorders like type 2 diabetes, atherosclerosis.

Entanglement of Amino Acids:

In August 2025, Edward O'Brien (Professor of chemistry at Eberly College of Science) in his research paper described that new class of protein misfolding involves a change in entanglement status in protein structure. Entanglement is a string of amino acids looping around each other like a knot. Sometimes entanglement happens when its not needed and sometimes it is absent in the protein where it has entanglement in its native structure. O'Brien said that "Most protein misfolding are quickly fixed but this type of entanglement is difficult to fix as they can be very stable".

Recent Contributors:

In the year 2020 ,Demis Hassabis and John Jumper presented an AI Model AlphaFold2. With its help they were able to find the structure of all proteins. Their AI model has been widely used in research in environmental technology and pharmaceuticals. For this invention they were also honoured with the Nobel Prize in Chemistry in the year 2024.

Conclusion:

Understanding precisely about protein misfolding will help us to understand its mechanism and role in certain diseases and aging. It will also provide new diagnostic methods to fight against some deadly diseases.

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Space physiology

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Introduction:

Space Physiology is about the effects of space travel on the human bodies. It is the study of the effects on the space environment -microgravity on the human bodies. In space there are many physiological effects on the body like cardiovascular system, musculoskeletal system, neurocognitive system and so on. The Challenges of space travel are complex. Physiological adaptations to spaceflight involve several multisystemic responses on human health and functions.

Effects of Microgravity on The Body :

Cardiovascular system:- In space there is a microgravity environment, which means some mechanical force on the body which is absent on the earth. On the earth there is too much gravity, that's why our body systems work differently. Thus the heart needs to work hard to pump the blood up to the brain.

Musculoskeletal System:- Another physiological problem is muscle loss. In a microgravity environment muscles cannot work hard. Muscles deteriorate when they are not used to space light. Studies have shown up to 24% loss of calf muscles after more than 100 days in space. Bone is directly affected by muscle strength, notably at muscle attachments. Given this most effective exercise, , primarily targeting muscle mass and strength.

Neurocognitive System:- For long duration human spaceflights have increased leading to the discovery of numerous effects on the CNS (central nervous system). Space cognitive neuroscience seeks to understand how the brain and mind react to the special environment condition on the space.

Other Effects of Space Travel on The Body:

Radiation:- The risk of radiation to humans in space is one of the major threats to astronauts. There are different types of radiation in space, mainly solar X-rays, solar flare neutrons and gamma rays, protons and extra cosmic rays. Effects of radiation might be radiation sickness, vomiting, blood count, haemorrhaging or death.

Sleep disturbance:- The unusual environment of space can disturb sleep patterns leading to fatigue and other issues.

Countermeasures:

Exercise:- Regular exercise can help maintain muscle mass and bone density.

Resistance bands:- Resistance bands can be used to provide resistance and help maintain muscle strength.

Diet Food and Nutrition:-

For diet, it has been recognized that special care has to be taken and numerous factors must be considered. The food must be nonperishable (for months to years), the drinks powdered, and the meals freeze-dried so that only water is added on board and mixed into the food. Many meals are heated to high temperatures to make them long lasting. All efforts must be made to avoid food poisoning, which could be life threatening for the entire crew.

Space Suit Mechanics: -

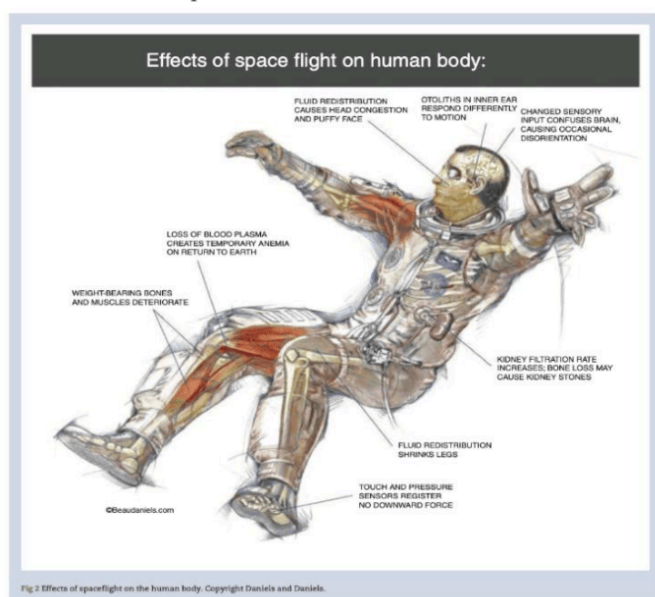
A mechanical counterpressure (MCP) suit or space activity suit (SAS) is an experimental spacesuit which applies stable pressure against the skin by means of skintight elastic garments. It uses mechanical pressure, rather than air pressure, to compress the human body in low-pressure environments. It means space suits have too much protection.

Conclusion:

The outer space is a hostile medium threatening the humans with microgravity, closed environment, low motor activity and space radiation. The force of gravity is important for the evolution of life as it influences the structure of organs, development, functions and behaviour of all living organisms.

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AI in Medicine: When Machines Begin to Heal

Author – Humaira Khan

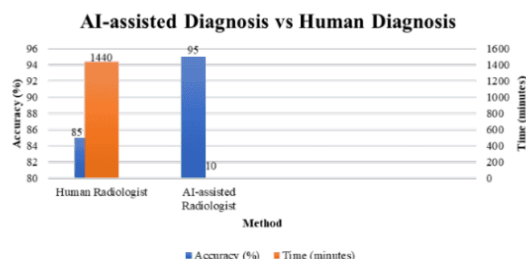
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Introduction:

Once confined to science fiction, artificial intelligence has found a new calling that is saving lives. In hospitals and research labs, AI is helping doctors read scans, predict illnesses, and even design the medicines of tomorrow. Behind every screen of data lies a simple goal is to heal smarter, faster, and more humanely.

AI & Medical Diagnosis:

Imagine a room stacked high with scans, lab results, and patient histories and now imagine a system that can sort through all of it in seconds, spotting patterns that might escape the human eye. That's AI stepping in: analyzing MRIs and ultrasounds, combining wearable and electronic health data, and assisting doctors rather than replacing them. Also AI systems averaged just over 50% accuracy compared to clinicians. But the story isn't about robots taking over; it's about machines helping humans work faster, catch cases earlier, and make smarter decisions.

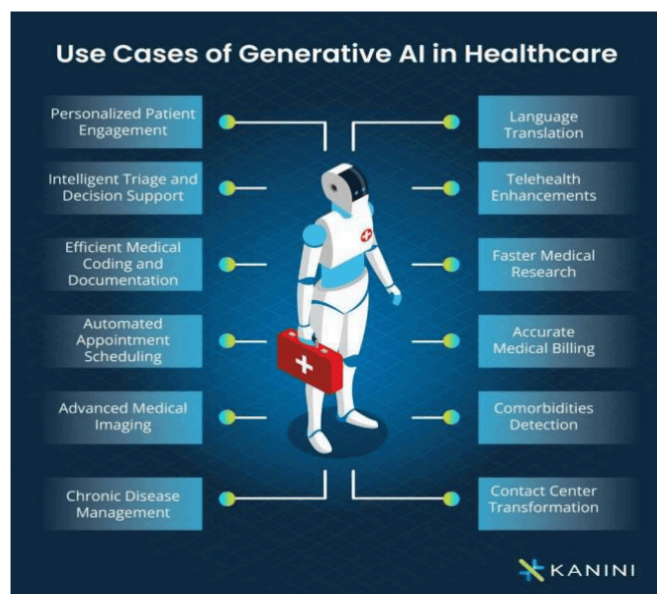


AI in Drug Discovery:

What used to take decades in dusty labs is now happening on glowing screens. Instead of testing thousands of molecules one by one, algorithms can now predict which structures might actually work against a disease. In 2020, Insilico Medicine used AI to design a potential lung-fibrosis drug in less than 18 months, a process that normally takes up to five years. BenevolentAI followed a similar path, using data-driven predictions to identify baricitinib as a possible COVID-19 treatment. These stories mark a shift: medicine isn't just experimenting anymore, it's computing possibilities.

Real-World Implementations of AI in Medicine:

Artificial intelligence isn't just some high-tech gadget anymore it's becoming a real partner in healthcare. It helps doctors make smarter decisions, lightens their workload and even finds new ways to connect with patients. From spotting health issues early to helping manage treatment, AI is quietly making medicine more precise, thoughtful, playful and caring.



AI's Blessings and Boundaries

Benefits of AI	Limitations of AI
Analyzes thousands of scans in seconds	Can produce false positives/negatives
Suggests potential drugs quickly	Biased if trained on limited data
Monitors patients continuously	Cannot replace human judgement or empathy
Supports personalized medicine	Requires high quality data
Improves early disease detection	Needs constant human oversight
Reduces time in research & trials	Data privacy and ethical concerns

Table 1: Key Benefits and Limitations of AI in Medicine

AI Uncovers a New Cancer Treatment Pathway:

A recent collaboration between DeepMind and Yale University used an AI model called C2S Scale 27B to identify a potential new therapy for "cold" tumor cancers that escape immune detection. The model suggested pairing the drug silmitasertib with low-dose interferon, a combination later confirmed effective in lab tests. This marks one of the first times AI has generated and validated a biological hypothesis, hinting at a future where machines help design cancer treatments once beyond human reach.

Beyond the Horizon: The Future of AI in Medicine:

AI's future in healthcare lies in deeper precision and personalization. Soon, algorithms will integrate genetic data and lifestyle patterns to design patient-specific treatments. In drug discovery, AI models may predict molecule behavior and side effects long before clinical trials, saving years of work. Hospitals will grow "smarter," using AI to manage patient flow and predict emergencies. Yet, as technology advances, ethical issues like data privacy and algorithmic bias must be addressed to ensure trust and fairness in medicine.

Conclusion:

AI in medicine is not about replacing doctors but it's about making care smarter, faster, and more personal. From spotting hidden patterns in scans to predicting how a patient's body will respond to a drug, AI acts as a powerful partner to human insight. Yet, at the heart of healing is still compassion, trust, and understanding things, no algorithm can replicate. The future of healthcare belongs to teams where humans and machines work together: data and empathy, precision and care, knowledge and humanity, all moving toward the same goal that is better health for every patient.

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The Light Behind the Mind : Unveiling the Biochemical Currents of Consciousness

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Introduction:

Consciousness is the essence of who we are. It allows us to be aware of ourselves, to think, to feel, and to experience the world. For centuries, it has fascinated philosophers and scientists alike. Today, neuroscience and biochemistry are beginning to reveal how our thoughts, sensations, and awareness arise from the activity of the brain.

The Neural Symphony: A Dance of Signals

At the center of consciousness is the brain, a remarkable network of cells called neurons. These neurons communicate through tiny electrical signals that travel from one cell to the next. When a signal reaches the end of a neuron, it triggers the release of chemical messengers known as neurotransmitters. These chemicals carry the message to neighboring neurons, forming intricate networks that underlie every thought, sensation, and perception.

Certain regions of the brain play a particularly important role in awareness. The thalamus, for example, acts as a relay station, sending sensory information to the cortex, where it is interpreted and integrated. This pathway allows the brain to focus on what is important and to maintain a continuous experience of the present moment. When these circuits are disrupted by injury or disease, consciousness can be profoundly affected, leading to conditions such as coma or a minimally conscious state.

Biochemical Modulators: The Subtle Influencers:

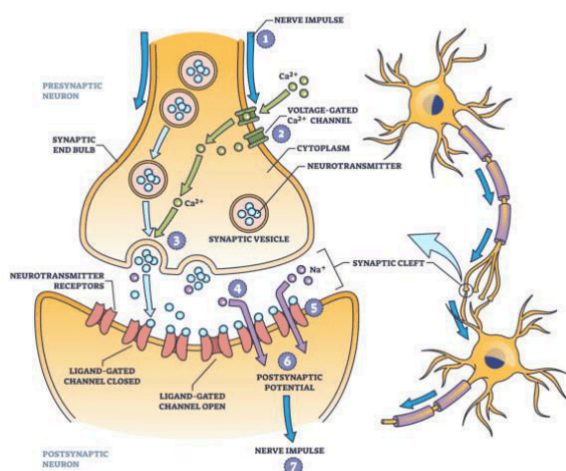
Neurons form the structural network of the brain, but chemical messengers called neurotransmitters. Dopamine, serotonin, and acetylcholine are among the most important players, influencing mood, attention, and awareness. Dopamine, often called the “molecule of motivation,” drives reward-seeking behavior and feelings of pleasure. Serotonin helps regulate mood, sleep, and emotional balance, while acetylcholine plays a key role in learning, memory, and focus.

Even small imbalances in these chemicals can change how we perceive the world, think, and feel. Such disruptions can contribute to psychiatric and neurological disorders, highlighting just how crucial these neurotransmitters are for maintaining the delicate flow of consciousness.

Consciousness in Clinical Practice:

Understanding how the brain's biochemistry and neural networks give rise to consciousness has important implications for medicine. Disorders of consciousness, such as coma, vegetative state, or minimal consciousness, often occur after brain injuries, strokes, or neurodegenerative diseases. Today, tools like functional MRI (fMRI) and electroencephalography (EEG) allow doctors to see the brain in action. They can monitor how different regions communicate, assess levels of awareness, and track recovery over time. These advances help clinicians make more accurate diagnoses, guide treatment plans, and provide hope to patients and their families, improving both outcomes and quality of life.

MECHANISM OF ANTIDEPRESSANTS



The Memory Theory of Consciousness:

One compelling idea is the Memory Theory of Consciousness, which suggests that our awareness arises from the brain's ability to integrate, store, and recall information. In this view, what we experience as the present is actually a continuous reconstruction of past memories, actively shaped by the brain. Clinical evidence supports this perspective: patients with memory impairments often show fragmented or altered conscious experiences, highlighting how memory is essential for maintaining a coherent sense of self.

Looking Ahead : The Future of Consciousness Research

Despite remarkable progress, the complete neurobiological basis of consciousness remains one of science's greatest mysteries. Researchers continue to explore how biochemical and neural processes work together to create awareness and self-experience. Future studies are beginning to look beyond neurons to include glial cells, which support and regulate brain activity, the blood-brain barrier that maintains the brain's internal environment, and even the gut microbiome, whose influence on mood and cognition is only beginning to be understood.

At the same time, advances in neurotechnology and artificial intelligence are opening new frontiers. Brain-computer interfaces, high-resolution neuroimaging, and AI-based models of neural activity may soon allow scientists to decode patterns of thought, enhance cognitive function, or even simulate aspects of consciousness itself.

Consciousness remains one of the most profound questions in science. As we continue to uncover the biochemical currents and neural symphony that shape our awareness, we move closer to understanding not just how the brain works, but what it truly means to be human.

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The Cell Membrane: Gateway to the Micro World

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Introduction:

Picture a small city within each and every living cell. A thin barrier protects it from the world outside. This barrier, the cell membrane, maintains everything in equilibrium. It allows certain things to pass through while preventing others. This selective permeability is what makes life possible. Without it, cells would not be able to live in their watery environments.

Learning about the Fluid Mosaic Model:

The cell membrane's structure is explained in the fluid mosaic model. It was conceived in 1972 by scientists. It presents the membrane as a sheet that can bend and contains many moving components.

The model derives its name from two prominent characteristics. First, the membrane is fluid. Lipids and proteins move easily. Second, it resembles a mosaic. Proteins cover the surface like tiles on a painting. This arrangement allows the membrane to change perform well.

Why is this important? The fluid mosaic model explains why cells adapt to change. It demonstrates that the membrane is not rigid. Rather, it curves and shifts as necessary.

Phospholipid Bilayer: Basis of Partitioning

Phospholipids construct the bulk of the cell membrane. They each have a head that adores water and tails that abhor it. This is referred to as amphipathic.

These molecules align in water. Heads point away from the water. Tails go inside, away from the water. This creates a bilayer, similar to two pieces of a sandwich.

The tails are carbon-hydrogen fatty chains. They bond with each other because they exclude water. This self-assembly forms a tight barrier. It separates the inside of the cell from the outside. This bilayer is roughly 7 to 10 nanometers thick. Thinner than a piece of paper. Yet it keeps the cell intact in harsh environments.

Membrane Proteins: Function Embedded Within the Fluid

Proteins give strength to the cell membrane. They drift in the fluid bilayer. Some stretch from one side to the other. These are integral proteins. Others sit atop the surface. We refer to them as peripheral proteins. Integral ones function as channels or pumps. They allow particular molecules to pass through. Peripheral proteins bind to the inside or outside. They assist with support or signaling. Surface receptors receive messages from the outside. Enzymes accelerate reactions on the membrane itself. Anchors bind the cell to neighbors. Collectively, these proteins make the membrane a bustling workplace.

Approximately 50% of the mass of the membrane is due to proteins. In the cells of humans, this may approach 50%. They make a simple barrier into an intelligent barrier.

Cholesterol and Glycocalyx: Regulating Fluidity and Recognition:

Cholesterol is found between phospholipids in animal cells. It prevents the membrane from becoming too rigid or too flaccid. At low temperatures, it prevents the tails from packing close together. In warm weather, cholesterol restricts movement. This keeps the membrane in just the right amount. Plants do the same thing with other kinds of molecules. The glycocalyx covers the outside. It contains sugars attached to proteins and lipids. These glycoproteins and glycolipids assist cells in recognizing one another. Imagine it like a name tag. It allows immune cells to find friends from enemies. The glycocalyx prevents germs, too.

In other cells, it helps to stick to surfaces. This coating varies with cell type and health.

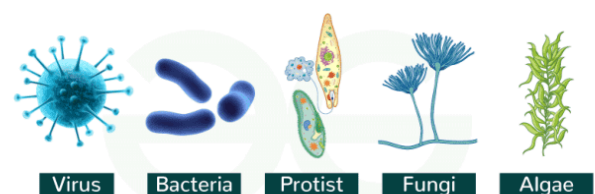
Selective Permeability: Regulating Traffic In and Out

The cell membrane selects what comes in and goes out. This selective permeability keeps things balanced within the cell. Life requires stable conditions, such as salt concentrations or pH. If it weren't controlled, the cell would be overrun with garbage. Or it could lose essential nutrients. The membrane is a wise gatekeeper. This process is related to homeostasis. Cells remain healthy by maintaining their insides different from the outside.

Passive Transport: Down the Gradient

Passive transport transports stuff without using energy. It occurs according to the natural flow, from a high to low concentration. Simple diffusion deals with tiny molecules. Oxygen and carbon dioxide pass through the bilayer. They dissolve in the tails easily. Large things require assistance. Facilitated diffusion employs proteins. Channels allow ions to pass, such as potassium. Carriers flip to transport glucose. No ATP is utilized here. It's all about the gradient pulling them along.

Water is transported through aquaporins in certain cells. This maintains hydration perfectly. Examples appear in the function of the kidneys.



Microorganisms - Useful Or Harmful



Active Transport: Fueling Uphill Fights

Active transport is counter to the flow. Active transport takes energy from ATP and drives molecules uphill. The sodium-potassium pump is a team star. It sends three sodium out and two potassium in. This creates a charge imbalance across the membrane.

That gradient drives nerve impulses. In your brain, it makes thoughts move quickly. Primary active transport depends directly on ATP. Secondary employs the gradient of primary pumps. Both maintain ions in balance. Without it, cells would not be able to take in nutrients from low places. Imagine it like a pump filling a pool against gravity.

In muscle cells, it balances things out after being squeezed.

Bulk Transport: Transporting the Masses

Bulk transport carries large burdens. It employs the membrane itself to enclose or release packages. Endocytosis takes things in. Pinocytosis sucks fluids in small vesicles. It is like drinking through a straw. Phagocytosis engulfs solids. White blood cells employ it to consume bacteria. They enclose a pouch around the invader. Exocytosis spits out things. Hormones exit cells by this method. Insulin is released from pancreas cells. These activities require energy. They mold the membrane but fix it fast. In amoebas, phagocytosis seizes food. In people, it sweeps away debris in the blood.

The Membrane as a Sensory and Communication Hub:

The cell membrane does not only protect. It feels the world and communicates with other cells. Proteins make it a center for information. This function maintains tissues coordinating with one another. The reaction of a single cell can influence the entire body.

Food or stress signals begin here. The membrane converts them into a response.

Signal Transduction Pathways

The membrane receptors bind ligands. These are similar to keys, including hormones. When the ligand binds, the receptor folds. This initiates a cascade within the cell.

The cascade makes the signal bigger. A single bind can initiate many steps. It results in gene modification or enzyme activity.

In adrenaline response, heart cells accelerate. The membrane pathway does it quickly. Phosphorylation attaches phosphate groups. This switches proteins on or off.

Mistakes here lead to illnesses such as cancer. Normal pathways maintain equilibrium.

Cell-to-Cell Recognition and Adhesion:

Cells adhere and converse through membrane components. The glycocalyx assists in identifying types.

Tight junctions close neighbors. They prevent leaks in skin or intestine.

Gap junctions connect cytoplasm. Ions and small molecules exchange. Heart cells coordinate beats thereby. Desmosomes grip tight. They attach in stressed muscle or skin. These junctions construct tissues. Without them, multicellular life disintegrates. During embryos, they direct cell sorting. Membrane Dynamics and Homeostasis. The cell membrane remains active. It renews and repairs to remain steady. This relates to overall body balance. Dynamics refer to constant change. Pieces flip, fuse, and reform. Homeostasis relies on this maintenance. It allows cells to respond to needs. Lipid Rafts and Membrane Organization Lipid rafts are floaty patches in the bilayer. They cluster certain lipids and proteins. These rafts coordinate tasks. Signaling occurs quicker here.

Cholesterol assists in their formation. They sort cargo for transport. In immune cells, rafts accumulate receptors. This increases defense. They enclose only 10-50% of the membrane. But they deliver. They have a big impact despite being confined to so little of the membrane.

Membrane Turnover and Repair:

Cells produce new components constantly. Old lipids are destroyed in lysosomes. Proteins are recycled also. This turnover makes the membrane new. Toxin damage initiates repair. Vesicles mend holes rapidly. In wounds, cells invert membrane to repair. It's a built-in repair system. It is an energy using process. But it assures long life for the cell.

Conclusion: The Indispensable Interface

The cell membrane is a barrier, a gateway, and a communicator. Its fluid mosaic structure manages transport with intelligence. From passive slips to active pushes, it regulates life's flow. Proteins and sugars bring senses and sticks. Dynamics prepare it for change. This thin sheet forms all biology. Healthy membranes equal healthy you. The next time you chow down or get moving, give thanks to this gateway to the micro world.

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Radiation and DNA Damage: When Cellular Fun Turns Fatal

Author~ Satish Makwana

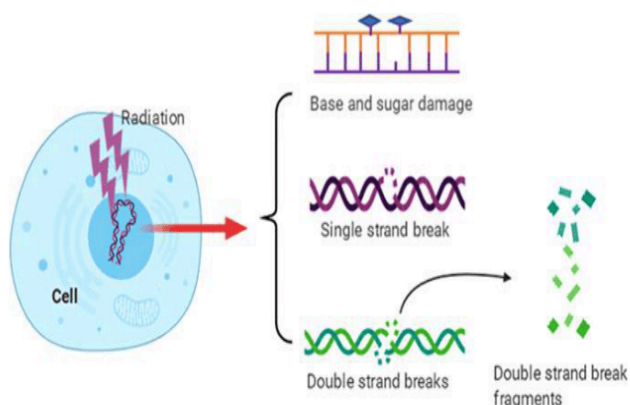
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Introduction:

Radiation is a form of energy that can affect living cells in many ways. In small amounts, it is helpful in medical tests and cancer treatment. But in high doses, radiation becomes harmful and can damage the DNA, which controls all cell activities. When radiation breaks or changes the DNA, the cell may stop working properly. Sometimes, the cell repairs itself, but if the damage is too big, it can lead to mutations, cancer, or cell death. Thus, radiation once useful for life can turn into a deadly force, showing how fragile cellular life really is.

Radiation and DNA Damage:

Radiation is a type of energy that can pass through living tissues. It is used in many fields like medicine, research, and industry. However, when the amount of radiation becomes too high, it can harm the cells. The most sensitive part of the cell is the DNA, which controls all genetic information. Radiation can break the DNA strands or change its structure, a process called DNA damage. This damage may stop the cell from working normally. Sometimes, the cell can repair the damage, but if repair fails, it can cause mutations, cancer, or cell death.



How Can Radiation Be Considered Cellular Fun:

Radiation can be called cellular fun because, at low or controlled levels, it helps scientists and doctors' study how cells work. In medical science, radiation is used in X-rays, CT scans, and cancer treatment to help or save human life. Inside the cell, small doses of radiation can sometimes stimulate repair systems and make the cell stronger. However, when the dose becomes too high, this "fun" turns dangerous. The same radiation that once helped the cell can damage its DNA, leading to mutation or cell death. So, radiation is both useful and harmful depending on how it is used.

Causes of DNA Damage:

DNA damage can happen when harmful agents attack the cell. There are many natural and man-made causes of DNA damage. The most common cause is radiation, such as UV rays from the sun, X-rays, and gamma rays. These can break the DNA strands or change its structure.

Chemical substances like pollutants, cigarette smoke, and pesticides can also damage DNA. Inside the body, normal cell activities produce reactive oxygen species (ROS) that may harm DNA if they become too high. In short, DNA damage is caused by radiation, chemicals, and internal stress within the cell.

How Cells Resist and Recover DNA Damage:

Cells have special ways to protect themselves from DNA damage. When radiation or chemicals harm the DNA, the cell quickly starts repair processes. There are special enzymes in the cell that can find and fix broken DNA. These enzymes cut out the damaged part and fill it with the correct DNA pieces. This process is called DNA repair. If the damage is small, the cell repairs it completely and works normally again. But if the damage is very big, the cell may stop dividing or die to protect the body from more harm.

Consequences When Cell Recovery Fails:

Sometimes, the cell cannot repair its damaged DNA. When this happens, serious problems can occur. The damaged DNA may cause mutations, which change the normal instructions of the cell. These mutations can make the cell grow in an uncontrolled way, leading to cancer.

If the damage is too large, the cell may stop working or die. In some cases, many damaged cells can make tissues or organs weak. So, when DNA repair fails, it can lead to diseases, aging, or cell death, showing how important DNA repair is for life.

Cellular Death – The Fatal Horror:

When a cell is badly damaged and cannot repair its DNA, it finally dies. This process is called cellular death. There are two main types of cell death. The first is apoptosis, also called *programmed cell death*. It is a natural and controlled process where the cell quietly removes itself without harming other cells. The second type is necrosis, which happens when cells die because of severe damage or toxins. It is an uncontrolled process and can harm nearby tissues. Thus, when DNA damage becomes too great, cell death is the final and fatal result.

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The Hidden Chemistry of the Human Brain

Author ~ Harsh Raval

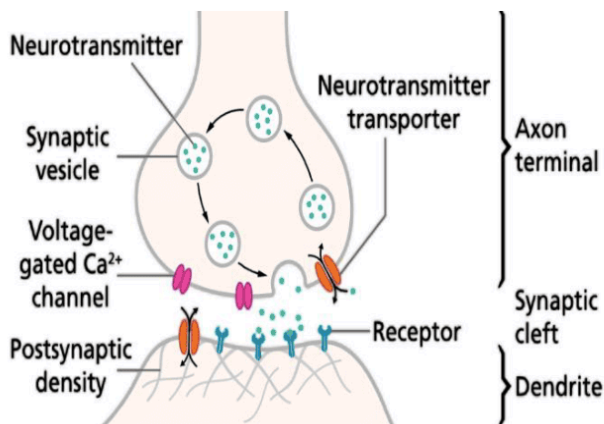
Department Of Biochemistry Semester 3 Student

Introduction :

The human brain weighing just about 1.4 kilograms controls every heartbeat, thought, and memory. Beneath its complexity lies an orchestra of biochemical reactions that govern nerve impulses, energy transfer, and cellular communication. Understanding the biochemistry of the nervous system has not only unraveled the mysteries of how we think but also illuminated the dark side of neurodegenerative diseases like Alzheimer's, Parkinson's, and Huntington's.

Neurotransmitters: The chemical messengers

Every thought and emotion begins with neurotransmitters small chemical molecules such as **acetylcholine, dopamine, serotonin, and glutamate**. These molecules transmit signals across synapses, the junctions between neurons. Recent research from the **Max Planck Institute (2023)** revealed that **dopamine release is modulated by nano-scale calcium domains**, redefining how we understand motivation and reward processing. This discovery has sparked new interest in personalized therapies for depression and addiction.



Energy and the brain: Bioenergetics in action:

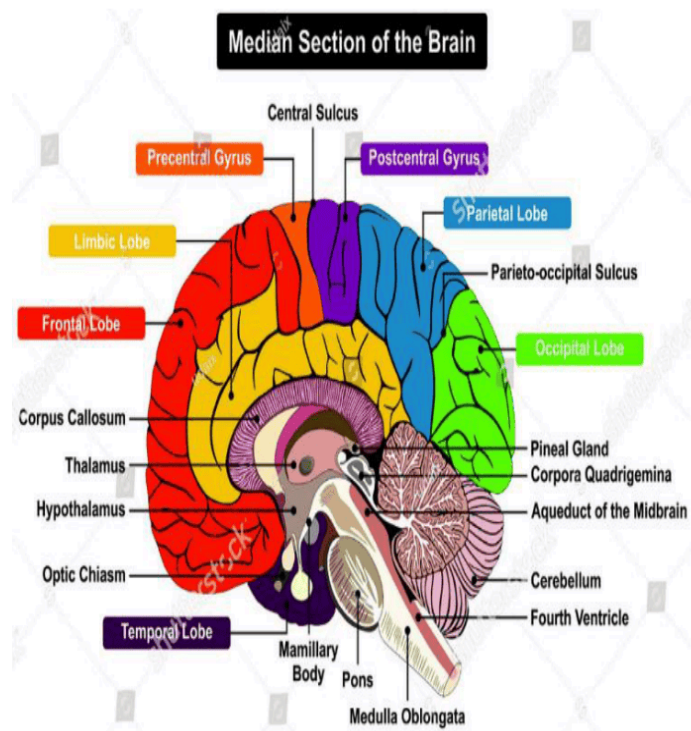
Although the brain makes up only 2% of body weight, it **consumes about 20% of the body's energy**. Most of this energy fuels the sodium-potassium ATPase pumps that maintain electrical potential across neuron membranes. A 2024 study published in Nature Metabolism discovered that **astrocytes (supporting brain cells)** play a vital role in **lactate shuttling** providing neurons with an emergency fuel supply during periods of high activity. This finding could pave the way for new treatments for ischemic stroke and brain injuries.

Molecular misfolding: The biochemistry of brain disorders

When proteins misfold, they can form toxic aggregates that kill neurons a hallmark of many neurodegenerative diseases.

- In **Alzheimer's disease**, abnormal accumulation of **amyloid- β** and **tau** disrupts cellular communication.
- In **Parkinson's disease**, **α -synuclein** aggregates lead to dopamine neuron death.

In 2023, researchers at **MIT** developed a **novel CRISPR-based technique** to correct genetic mutations responsible for misfolded proteins. Their success in animal models offers hope for treating these disorders at their biochemical roots.

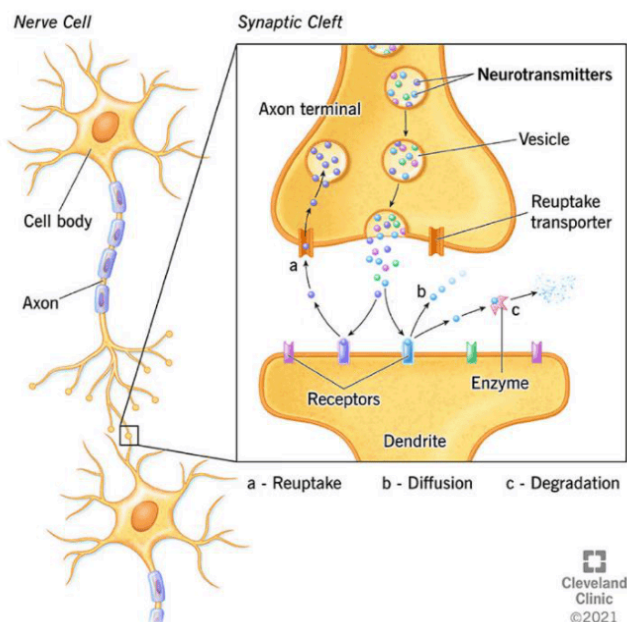


Neuroplasticity: Biochemistry behind learning and memory

Every time you learn something new, biochemical changes strengthen specific neural connections — a process called **long-term potentiation (LTP)**. This depends heavily on **glutamate receptors (NMDA and AMPA)**, calcium signaling, and protein synthesis. A groundbreaking discovery from **Stanford University (2024)** identified a molecule called '**Synaptozyme**', which enhances LTP efficiency and may help reverse age-related memory decline. This could revolutionize how we approach cognitive enhancement.

Emerging frontiers: Artificial intelligence meets biochemistry

Modern neuroscience is now merging with AI to decode biochemical brain activity. Using AI-based models, scientists can simulate neurotransmitter interactions, predict protein folding errors, and even design drugs to correct them. **The 2025 “Human Brain Project”** in Europe has already mapped millions of biochemical synapses, bringing us closer to creating digital twins of neural networks.



Conclusion :

From the electrical sparks of thought to the biochemical cascades of emotion, the nervous system exemplifies the beauty and complexity of life at the molecular level. As research advances, the hope for curing neurological disorders grows stronger. The study of nervous system biochemistry not only helps us understand who we are it may one day help us preserve the very essence of being human.

Quick Quiz: Test Your Neuro-Biochemical IQ!

1. Which neurotransmitter is primarily associated with mood regulation?

- a) Dopamine b) Serotonin c) GABA d) Acetylcholine

2. What type of cells supply energy to neurons through lactate shuttling?

- a) Astrocytes b) Microglia c) Oligodendrocytes d) Schwann cells

3. Which protein misfolding is linked to Parkinson's disease?

- a) Amyloid- β b) α -Synuclein c) Tau d) Prion

4. What is the percentage of body energy consumed by the brain?

- a) 10% b) 15% c) 20% d) 25%

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Environmental Toxicology

Author ~ Ashish Pargi

Department of Biochemistry Semester III Student

Introduction:

Field of study in the environmental sciences that is concerned with the assessment of toxic substances in the environment. Although it is based on toxicology, environmental toxicology draws heavily on principles and techniques from other fields including biochemistry, cell biology, and genetics. Among its primary interests are the assessment of toxic substances in the environment, the monitoring of environments for the presence of toxic substances, the effects of Toxins on biotic and abiotic components of ecosystems, and the metabolism and biological and environmental fate of toxins. One of the major components in environmental toxicology is air pollution.

Air Pollution:

Air pollution is a constant and menacing problem throughout the world due to man's own activities like industrialization and urbanization. It is increasing progressively during the past few decades. Air Pollution is not only a public health problem but also an economic problem.

Air Pollutants - These may be chemical or biological.

(i) Chemical Pollutants:

These may be particulate matter, gases or metals. Particulate matter: Dust, smoke, soot, sand, grit, etc. Gases: CO, CO₂, H₂S, CH₄, NO₂, SO₂, MIC (methylisocyanide), fluoro-hydrocarbons, etc. Metals: Arsenic, beryllium, copper, zinc, lead, carcinogens, etc.

(ii) Biological Pollutants:

These include pathogens (microbes), spores, etc. Although the earth's atmosphere above the surface only the first 30 kms that hold the major portion of the atmospheric gases. Pollutants are affected by sunlight and temperature inversion.

Sunlight:

The UV rays of the sun act on the oxides of nitrogen and other hydrocarbons and form photo-oxidants, which are irritant to conjunctiva, throat, nose and respiratory mucous membrane.

Temperature Inversion:

Normally air near the surface of the earth is warmer air, being lighter, moves up, expands and becomes cool. Thus, the pollution is diluted and dispersed while the air of the upper layer, being cool and heavy, comes down (turbulent flow). Under exceptional conditions, as in deep valleys, the temperature gradient is reversed, i.e. the air

near the surface absorbs infrared radiations and remains cool and the upper layer becomes warm. The temperature rises with increase in altitude. If fog is present under such conditions of temperature inversion, water vapor condenses around the smoke particles and forms smog (water vapor + smoke = smog). Intense smog is lethal. Such temperature inversion often persists for several days, resulting in acute episodes of respiratory illness, suffocation and death.

Highly susceptible population groups are young children, elderly people and those suffering from lung diseases and heart diseases. The famous episodes of this are the Bhopal gas disaster (Belgium) in December 1930 lasted for 5 days killing 63 people and many cattle, Donora (Pennsylvania) 1948 killing 20 people and hundreds became ill. London in 1952 was the deadliest smog due to domestic coal burning; more than 4000 people died.

The Bhopal gas tragedy in India 1984 killed thousands of people and it was due to leakage of methyl isocyanide gas in the Unicarbide industry, an example of air pollution not due to photo oxidants.

Sources of Air Pollution:

Burning of fire wood, kerosene oil, coal. factories of iron, steel, paper, cement, fertilizers, thermal power plant, petroleum refineries. Motor vehicles, railways, ships, aeroplanes. Tobacco smoking, nuclear explosions, forest fires, volcanoes, burning of refuse, dust storms, ocean spray.

Hazards of Air Pollution:

Immediate and Acute effects

Conjunctivitis, allergic rhinitis, acute pharyngitis, acute bronchitis and episodes of bronchial asthma (acute attacks).

Delayed and Chronic effects

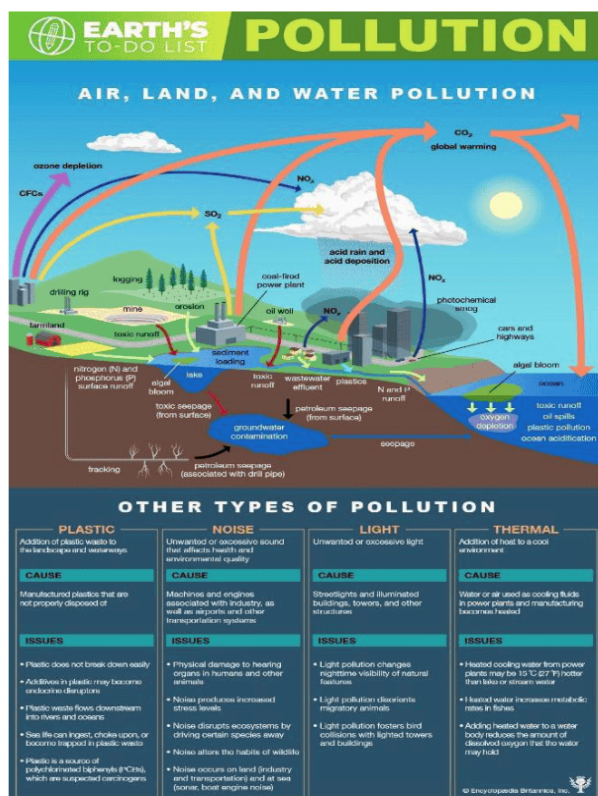
Chronic bronchitis, bronchiectasis, emphysema, chronic obstructive pulmonary disease (COPD), bronchial asthma and even lung cancer.

Global Effects of Air Pollution:

Acid rain: It is the end result of several processes like Sulfur dioxide emitted from combustion of coal produces sulfuric acid by getting dissolved in water vapor of the atmosphere. Same goes for CO₂- carbonic acid, NO₂. Nitric acid thus the rainfall containing these causes acidification of water and soil which harms trees and aquatic life like fish. Global warming: Atmospheric gases show greenhouse effect like the glass of a greenhouse allows light and warmth to reach the earth but don't allow them to be lost same with air pollution gases like CO₂, methane, CFC and accumulation

Depleted ozone shield: ozone layer filters the UV rays of the sun due to air pollution it begins to thin out resulting.

- Inhibition of photosynthesis
- Disruption of marine food chain
- Ocular damage
- Skin cancers
- Impairment of human immune mechanism, predisposing to infections
- UV rays damage small forms of life like plankton, pollen grains, soil bacteria
- Cattle become weak and cachexic. Yield of animal products becomes less.
- Damage to buildings like old monuments, to metals, alloys, textiles, rubber and works on wood, bronze and stone (like paintings, carvings)



Prevention and control of air Pollution:

1. Engineering technology : Location of industries must be located far away from the human habitations. Within the industries the processes causing air pollution should be replaced by the process of preventing air pollution. Like electricity instead of fuels using LPG in place of coal. Controlling the dust by wet method, enclosure hoods, exhaust pipes for removal.

2. Legalisation measures: To control air pollution Gov. Of India has enacted some acts like Indian Factories act, Prevention and control of Air pollution act, smoke nuisance act etc.

3. General measures: Control traffic by constructing by pass roads .Maintenance of vehicles by servicing, mixing of petrol and oil in proper proportions. Establishment of Green-belts i.e. growing trees between industrial and residential areas. Electrical vehicles and most important population stabilization.

Air Quality Index : Air quality index is the system used to warn the public when air pollution is dangerous.

Category, Color & Range	What does this mean?	Precautions to take
Good 0-50	Air quality is good.	None: Everyone enjoy outdoor activities.
Moderate 51-100	Air quality is a concern for people who are extra sensitive to air pollution.	People extra sensitive to air pollution: Plan strenuous outdoor activities when air quality is better.
Unhealthy for Sensitive Groups 101-150	Air quality is unhealthy for many people including active adults, people with lung disease (including asthma), older adults and children.	Sensitive groups: Cut back or reschedule strenuous outdoor activities.
Unhealthy 151-200	Air quality is unhealthy for everyone, especially people with heart or lung disease.	Everyone: Avoid strenuous outdoor activities.
Very Unhealthy 201-300	Air quality is unhealthy for everyone, especially people with heart or lung disease.	Everyone: Avoid physical outdoor activities.
Hazardous 301-500	Air quality is hazardous for everyone.	Everyone: Avoid all outdoor activities.

CONCLUSION:

To prolong the regular and healthy life including the living organisms around us we have to stay aware of what's beneficial for us and others too, not only in the aspect of air but all the possible aspects which leads to harm of our environment and the mother land so if we take care we can sleep well.

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Author : K. Park

Cramps: Blood Cells and Bioengineering

Author ~ Harsh Pandya

Department of Biochemistry Semester III Student

Introduction:

Muscle cramps are sudden, involuntary contractions of one or more muscles that cause intense pain and stiffness. While they are common after exercise or dehydration, the biochemical and cellular mechanisms behind cramps are far more complex than they appear. Understanding the role of blood cells and recent bioengineering approaches provides fascinating insights into how cellular functions maintain muscular health and what happens when these processes fall apart.

The Biochemistry Behind Cramps:

At the physiological level, muscle contraction depends on a delicate balance of electrolytes—mainly sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+})—and the ATP-driven movement of these ions across membranes. During contraction, calcium ions are released from the sarcoplasmic reticulum, initiating the interaction between actin and myosin filaments. For relaxation, calcium must be pumped back, a process requiring ATP. If there's ATP depletion or ion imbalance, calcium remains trapped in the cytosol, keeping the muscle in a sustained contraction of what we feel as a cramp.

Role of Blood Cells in Cramps:

Blood cells, especially red blood cells (RBCs), play a key role in supplying oxygen and maintaining acid-base balance. Oxygen delivery is essential for ATP generation through aerobic respiration. When oxygen delivery drops (as in strenuous exercise or dehydration), anaerobic metabolism increases, producing lactic acid and lowering pH. This acidic environment affects nerve excitability and ion channels, making muscles more prone to cramping. Meanwhile, white blood cells (WBCs) and inflammatory cytokines come into play after repeated cramping episodes, as micro-tears in muscle tissue trigger immune responses.

Cellular Fallout: When Balance Breaks:

When the finely tuned biochemical balance of a muscle cell is disturbed, the fallout can be severe:

- Dehydration and electrolyte loss reduce nerve transmission efficiency.
- Low oxygen tension impairs ATP synthesis.
- Calcium pump failure keeps muscle fibers locked in contraction.

Over time, such imbalances can lead not only to cramps but also to muscle damage, oxidative stress, and even rhabdomyolysis a condition in which muscle breakdown releases myoglobin into the bloodstream.

Bioengineering Approaches to Understand and Prevent Cramps:

Modern bioengineering is revolutionizing how we study and treat muscle physiology. Some major breakthroughs include:

1. **Bioengineered Muscle Tissues:** Scientists have developed lab-grown skeletal muscle fibers using human stem cells. These 'muscles-on-chips' mimic natural contraction cycles and allow researchers to study cramps at a cellular level.
2. **Microfluidic Blood Flow Models:** Engineers have designed microfluidic systems that simulate blood flow and oxygen delivery to muscles, helping test how red blood cells behave under dehydration or low oxygen.
3. **Wearable Biosensors:** Smart patches and biosensors can now monitor electrolyte levels, muscle electrical activity, and lactate accumulation in real time.
4. **Gene and Protein Engineering:** Researchers are exploring genetic variations in ion channels and proteins like dystrophin, which influence muscle excitability. Targeted gene editing or protein modulation could provide personalized therapies for cramp-prone individuals.

Fun Facts:

- The word 'cramp' comes from the Old French 'crampe', meaning "bent" or "crooked."
- Most nocturnal leg cramps occur during REM sleep.
- Potassium-rich foods like bananas or coconut water help restore ionic balance and prevent cramps.

Conclusion:

Cramps are not merely a momentary muscular inconvenience—they are the result of intricate biochemical interactions involving blood cells, electrolytes, and cellular metabolism. As bioengineering continues to merge with physiology, scientists are closer than ever to decoding the molecular triggers behind cramps and designing effective prevention methods.

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Trojan Horse Bacteria Sneak Cancer-Killing Viruses into Tumours

Author ~Shrey patel

Department Of Biochemistry Semester V Student

Introduction:

Researchers at Columbia Engineering have built a cancer therapy that makes bacteria and viruses work as a team. They have used a tumor-seeking bacteria as a trojan horse that encapsulates the cancer-killing virus to invade the patient's immune system without generating an immune response to produce antibodies against the virus. This was accomplished by bridging bacterial engineering with synthetic virology to create a system called CAPPSID (short for Coordinated Activity of Prokaryote and Picornavirus for Safe Intracellular Delivery). The approach combines the bacteria's instinct for seeking tumors with a virus's capability for infecting and killing cancer cells.

Sneaking Past The Immune System:

The bacteria act as an invisibility cloak, hiding the virus from circulating antibodies, and ferrying the virus to where it is needed.

Targeting The Tumor:

Salmonella typhimurium naturally migrates to the low-oxygen, nutrient-rich environment inside tumors. The bacteria invade cancer cells

Bacterial cells lyse themselves directly inside of cancer cells to release the viral genome

Virus/viral RNA is released directly in the tumor microenvironment & spread between cancer cells

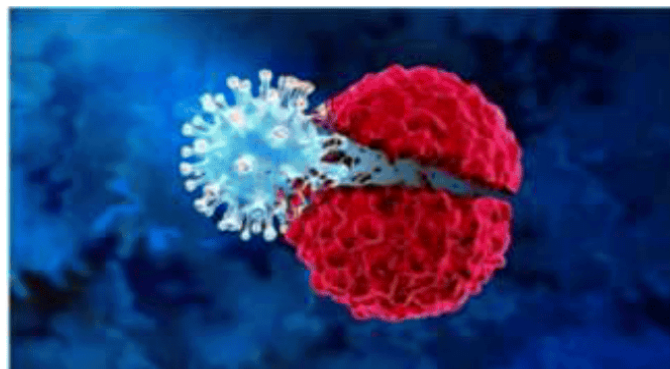
Safeguarding Against Spreading of The Infection by Virus:

In order to ensure that the virus does not spread beyond the tumor they made sure that the virus is somehow dependent on the bacteria for a component called "protease" which is essential for the machinery required for maturation of the virus. Hence it cannot spread and infect healthy cells. Since the bacteria stay put in the tumor, this vital component (called a protease) isn't available anywhere else in the body. Hence providing a synthetic dependency between the microbes.

Further Research and Clinical Applications:

The technology has been validated in mice & represents the first example of directly engineered cooperation between bacteria and cancer-targeting viruses. The team is expanding their research by testing the method in more types of cancer. They're using different tumors, mice, viruses, and therapeutic payloads to build a flexible "toolkit" of virus-based treatments that can detect and react to specific conditions inside cells. They're also exploring how to combine this system with safe strains of

bacteria that have already been tested in human



Myth: Hemorrhages Only Occur in The Brain

Debunked:

A hemorrhage is a fancy term for 'internal bleeding'. Now the most common form of this shown in movies is a brain hemorrhage, typically given rise to by trauma. However, it is important to understand that hemorrhages can happen pretty much anywhere in the body! And no, the argument that 'inside – that's where blood is supposed to be' doesn't fit because we have a closed circulatory system,



References:

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Pathological and Clinical Management of Metabolic Disorders

Author-Mahi Vaidya

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Introduction:

Metabolic disorders are conditions that disrupt normal metabolism, the process your body uses to convert food into energy. These disorders can result from genetic defects, hormone imbalances, or damage to the organs involved in metabolism, such as the liver, pancreas, or thyroid.

With the rise of lifestyle-related diseases and increased genetic screening, metabolic disorders have become an area of growing concern and research.

What is Metabolism?

Metabolism refers to all chemical reactions in the body that maintain life. These reactions are responsible for:

- Breaking down nutrients to produce energy
- Building and repairing tissues
- Regulating bodily functions (e.g., temperature, pH, and blood sugar)

A metabolic disorder occurs when abnormal chemical reactions disrupt this balance, either by producing too much or too little of certain substances.

Causes of Metabolic Disorders:

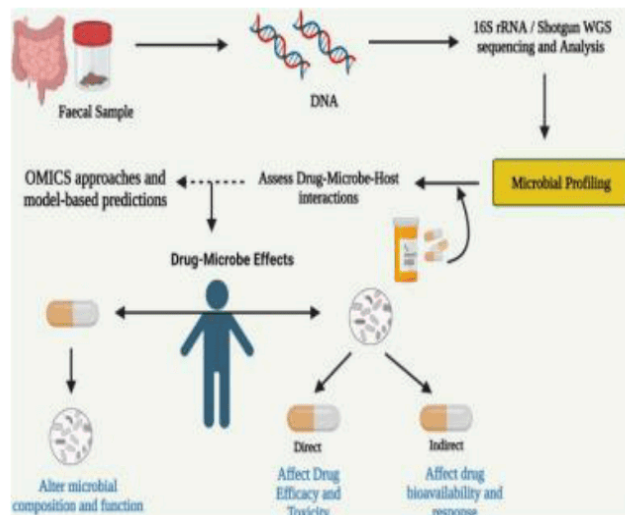
Metabolic disorders can be **inherited** (genetic) or **acquired** (developed later in life).

1. Genetic Causes

- Result from mutations in genes that control metabolic enzymes
- Often diagnosed in infancy or childhood
- Examples: Phenylketonuria (PKU), Gaucher disease, Tay-Sachs disease

2. Acquired Causes

- Poor diet and sedentary lifestyle
- Hormonal imbalances (e.g., thyroid disorders)
- Organ dysfunction (especially liver, pancreas, kidneys)
- Medications or toxins



Common Symptoms:

Symptoms vary depending on the specific disorder, but common signs include:

- Unexplained weight gain or loss
- Fatigue and weakness
- Muscle cramps or pain
- Developmental delays (in children)
- Frequent infections
- Digestive issues (nausea, vomiting, constipation)
- Low or high blood sugar levels

Types of Metabolic Disorders:

1. Diabetes Mellitus

A condition where the body either doesn't produce enough insulin or cannot use it effectively. Leads to high blood sugar levels.

2. Thyroid Disorders

• **Hypothyroidism:** Slowed metabolism due to low thyroid hormone levels • **Hyperthyroidism:** Overactive metabolism from excess thyroid hormone

3. Inborn Errors of Metabolism

Rare genetic conditions where specific enzymes are missing or dysfunctional. Includes:

- Phenylketonuria (PKU)
- Maple syrup urine disease (MSUD)
- Galactosemia

4. Metabolic Syndrome

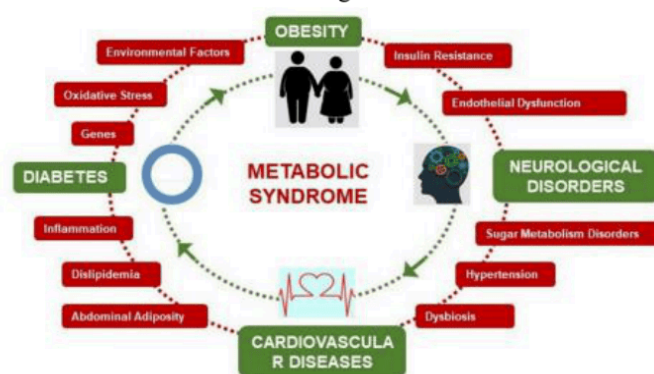
A group of risk factors (high blood pressure, high blood sugar, abnormal cholesterol, and abdominal fat) that increase the risk for heart disease and diabetes.

Diagnosis:

Diagnosing a metabolic disorder typically involves:

- **Medical history and physical exam**
- **Blood and urine tests** to check for abnormal levels of enzymes, hormones, or metabolites
- **Genetic testing** (for inherited conditions)
- **Imaging tests** to assess organ function (e.g., liver or thyroid)

Early diagnosis is crucial, especially in newborns, as some conditions can be life-threatening if untreated.



Treatment and Management:

Treatment depends on the specific disorder and may include:

1. Medications

- Hormone replacements (e.g., thyroid hormone)
- Insulin or oral drugs for diabetes
- Enzyme replacement therapy (for some genetic disorders)

2. Dietary Changes

- Avoiding specific nutrients (e.g., phenylalanine in PKU)
- High-protein or low-carbohydrate diets
- Frequent small meals to maintain energy levels

3. Lifestyle Modifications

- Regular exercise
- Weight management
- Avoiding alcohol or certain drugs

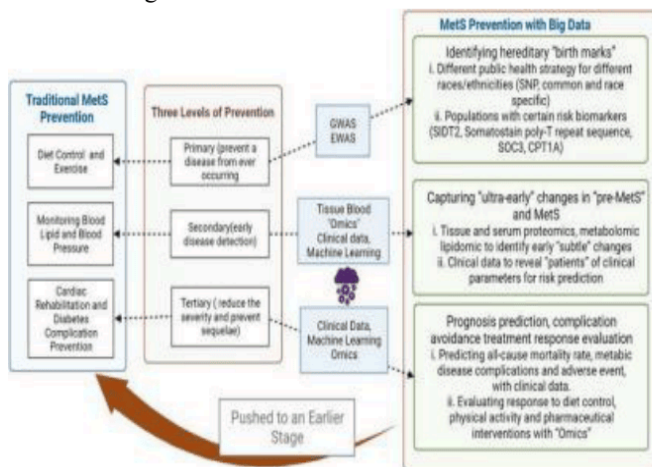
4. Monitoring

- Regular follow-up with specialists (e.g., endocrinologist, dietitian)
- Routine blood work to monitor metabolic control

Prevention:

While genetic metabolic disorders can't be prevented, some acquired forms can be reduced by:

- Maintaining a healthy weight
- Eating a balanced, nutritious diet
- Staying physically active
- Managing stress
- Avoiding tobacco and excessive alcohol



Conclusion:

Metabolic disorders encompass a wide range of conditions that can impact overall health if not diagnosed and managed appropriately. While some are rare and inherited, others are increasingly common due to lifestyle factors. With proper medical care, lifestyle changes, and early detection, most metabolic disorders can be effectively managed to improve quality of life and prevent complications.

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Beyond the Buzz : Understanding Nicotine Impact on Your Body

Author ~ Kaveri Rohitgiri Goswami

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Introduction:

Nicotine is a colorless, oily alkaloid that is naturally produced in the tobacco plant (*Nicotiana tabacum*) and, in trace amounts, in other plants of the nightshade family. First isolated in the 19th century, it has since become known as the primary psychoactive agent responsible for tobacco addiction. It is a dual-natured compound that acts as a toxin in insects and when consumed, nicotine rapidly enters the bloodstream and stimulates the brain to release dopamine, creating a temporary feeling of pleasure and alertness. However, this effect is short-lived, which drives a cycle of repeated use that leads to a powerfully addictive dependence. While nicotine itself is not considered a primary carcinogen, it is the addictive component that keeps users dependent on tobacco products, which contain thousands of other harmful chemicals and beyond addiction, nicotine has other significant physiological effects that are explored in detail in this article

How does it work in the body and how the body reacts to it:

The neurobiology of nicotine addiction, explaining that nicotine's primary action is on cholinergic receptors, which then triggers a cascade of effects in the brain. It highlights the critical role of the **dopaminergic system** in addiction, as nicotine increases dopamine release, reinforcing addictive behaviors.

Mechanism of Action:

• Cholinergic receptors:

Nicotine's effects begin with it interacting with **nicotinic acetylcholine receptors** in the brain.

• Acetylcholine release:

This binding stimulates presynaptic cholinergic receptors, leading to the enhanced release and metabolism of acetylcholine itself.

Role of Different Neuro-Transmitter Systems

• Dopaminergic system:

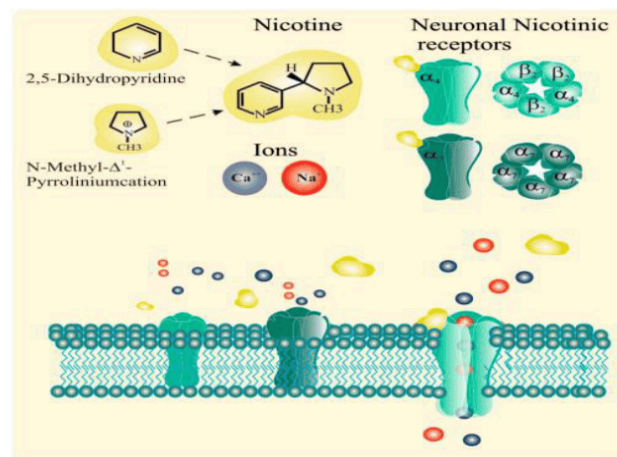
Nicotine-induced activation of cholinergic receptors leads to the stimulation of the dopaminergic system, particularly in the **nucleus accumbens**.

• Reinforcement:

This increased dopamine concentration is responsible for the reinforcing properties of nicotine, which leads to behavioral changes, dependence, and craving.

Other Systems:

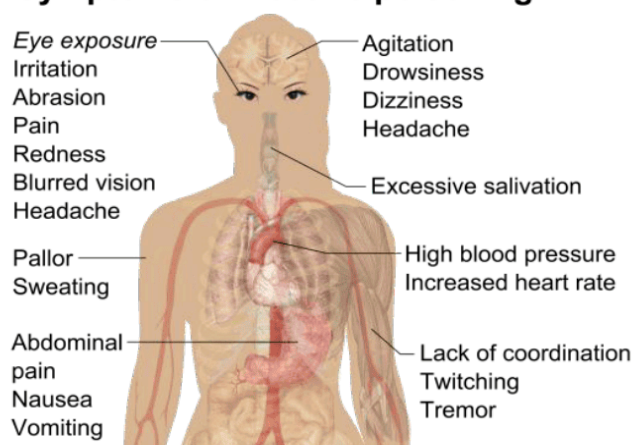
The article notes that other systems, such as the serotonergic, GABAergic, and noradrenergic systems, also play a role in the rewarding effects of nicotine and the withdrawal symptoms that occur when its use is stopped.



Signs & Symptoms:

Nicotine poisoning tends to produce symptoms that follow a biphasic pattern. The initial symptoms are mainly due to stimulatory effects and include nausea and vomiting, excessive salivation, abdominal pain, pallor, sweating, hypertension, tachycardia, ataxia, tremor, headache, dizziness, muscle fasciculation, and seizures. After the initial stimulatory phase, a later period of depressor effects can occur and may include symptoms of hypotension and bradycardia, central nervous system depression, coma, muscular weakness and/or paralysis, with difficulty breathing or respiratory failure.

Symptoms of nicotine poisoning



Diseases:

These include many types of cancer (especially lung, throat, and bladder), heart and blood vessel diseases like heart attack and stroke, lung diseases such as COPD and asthma, and type 2 diabetes . It also causes various eye conditions, reproductive issues, & other health problems.

Cancer:

- Lung cancer.
- Cancers of the mouth, throat, esophagus, larynx, bladder, pancreas, kidney, and cervix.

Cardiovascular Diseases:

- Heart attack.
- Aortic aneurysm.

Respiratory Diseases:

- Chronic Obstructive Pulmonary Disease (COPD), which includes emphysema and chronic bronchitis.
- Acute respiratory illnesses like pneumonia.

Other Diseases:

- Certain eye diseases like cataracts and macular degeneration.
- Issues with the immune system, such as rheumatoid arthritis.
- Increased risk of tuberculosis infection and death from it.

Reproductive and developmental health effects:

- Miscarriage and preterm delivery.
- Low birth weight in babies.

Diagnosis and Treatment:

Increased nicotine or cotinine (the nicotine metabolite) is detected in urine or blood, serum nicotine concentrations increase. The initial treatment of nicotine poisoning may include the administration of activated charcoal to reduce gastrointestinal absorption. Treatment is mainly supportive and can include the control of seizures with a benzodiazepine, intravenous fluids for hypotension, and administration of atropine for bradycardia. Respiratory failure may necessitate respiratory support with rapid sequence induction & mechanical ventilation. Hemo-Dialysis, hemoperfusion, or other extracorporeal techniques are not useful in enhancing nicotine elimination. While acidifying the urine could theoretically enhance nicotine excretion, it is not recommended as it may cause complications of metabolic acidosis.

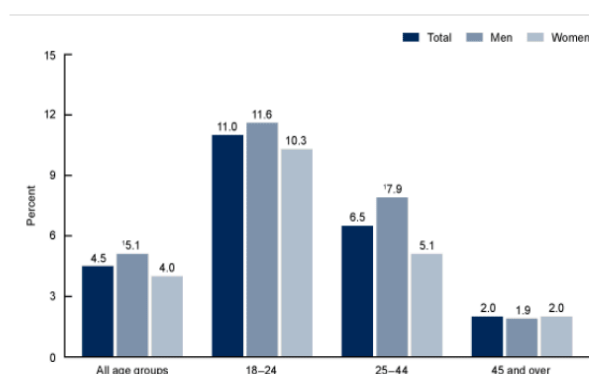
Precaution:

The best precautionary measures for nicotine focus on preventing exposure, addiction, and accidental poisoning. This is particularly important for liquid nicotine, which is used in e-cigarettes and can be highly toxic if ingested or absorbed through the skin.

1. Prevent access by children and pets.
2. Practice safe handling of nicotine products.
3. Quit or avoid nicotine use.
4. Create a smoke-free and vape-free environment.

Case Study:

Percentage of adults aged 18 and over who currently use e-cigarettes, by age group and sex: United States, 2021.



Results : The total percentage of adults using e-cigarettes in the US was 5.1%. This breaks down to 6.5% of men and 4.0% of women thus, men use more than women.

Comment : The data highlights that range of usage is substantially higher among younger adults (18-24) and decreases with each older age bracket including both the sex.

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Crashing Circuits : Cellular Breakdown & The Biochemistry of Coma

Author ~ PRACHI SOLANKI

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Introduction :

➤ Consciousness the product of billions of biochemical signals is sustained by the seamless function of cellular mechanisms. Within the brain, neurons and glial cells rely on a constant supply of oxygen, glucose, and ATP to maintain electrical excitability and intercellular communication. When this harmony is disrupted, the result can be devastating. One of the most dramatic consequences of global cellular failure is coma.

➤ In Robin Cook's medical thriller Coma, young patients undergoing minor surgeries inexplicably fall into irreversible unconsciousness. While fictional, the novel raises a crucial biomedical question: What happens at the cellular level when the brain shuts down? This article explores how disruptions in cellular physiology and biochemistry from mitochondrial failure to ionic collapse can trigger the descent into coma, tracing the path from cellular function to cellular fallout.

1. Cellular Harmony: The Biochemistry of Brain activity

➤ Neurons are metabolically demanding cells. They use ATP generated via aerobic respiration to maintain Na^+/K^+ gradients across their membranes. These gradients are essential for action potentials and synaptic transmission.

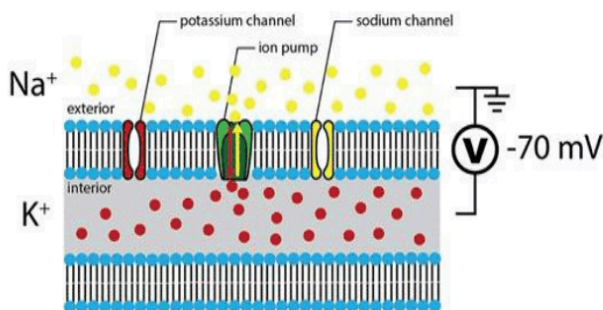


Fig. 1 : Ion pumps maintain electrochemical gradients essential for signalling

➤ Glial cells, especially astrocytes, regulate extracellular ion balance and neurotransmitter clearance. Mitochondria supply the necessary energy, while tight junctions in endothelial cells maintain the blood brain barrier (BBB) - a crucial protector of cerebral homeostasis.

2. Cellular Stress : The First Signs of Fallout

➤ When oxygen or glucose is depleted (e.g., during hypoxia), mitochondria fail to produce adequate ATP

This halts active ion transport, particularly the Na^+/K^+ ATPase. Sodium enters cells, potassium leaks out, and calcium accumulates.

➤ This leads to:

- Membrane depolarization
- Glutamate release
- Calcium overload
- Excitotoxicity (neuronal death due to overstimulation)

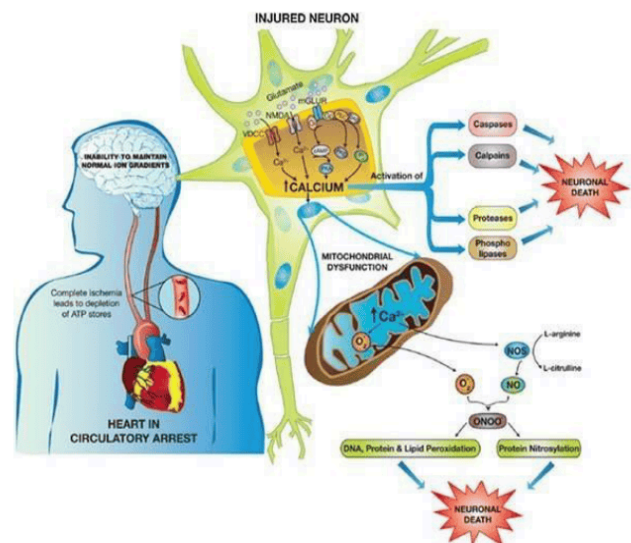


Fig. 2 : Excitotoxic and oxidative damage pathways during ischemia

➤ Excess calcium also activates proteases, lipases, and endonucleases, while reactive oxygen species from dysfunctional mitochondria cause oxidative damage. The cell swells and bursts, triggering necrosis or apoptosis.

3. Cellular Fallout : Systemic Breakdown Leading to Coma

➤ Coma arises when critical brain regions fail- particularly the reticular activating system in the brainstem and bilateral cortical networks responsible for arousal and awareness.

➤ Massive, global failure- such as after cardiac arrest, trauma, or toxin exposure- leads to:

- Loss of ATP
- Cytotoxic brain edema
- Neuronal network failure
- Suppression of cerebral metabolism

➤ Some metabolic comas (e.g., from hypo-glycemia) may not involve cell death initially, but rather reversible suppression of neural activity.

4. The Coma Cascade:

Normal Cell Function



Ischemia / Hypoxia / Metabolic Insult



ATP Depletion → Ion Pump Failure



Na⁺/K⁺ imbalance → Ca²⁺ influx → Glutamate Excitotoxicity



ROS generation → Mitochondrial failure → Cell death



Neuronal network collapse → RAS/Cortex suppression



Clinical Coma

5. Fiction Refelecting Science : Robin Cook's Coma

➤ In *Coma*, a hidden insult-carbon monoxide poisoning-deprives the brain of oxygen. This mirrors the real-life pathophysiology of hypoxic coma: rapid ATP depletion, excitotoxic injury, and irreversible network shutdown.

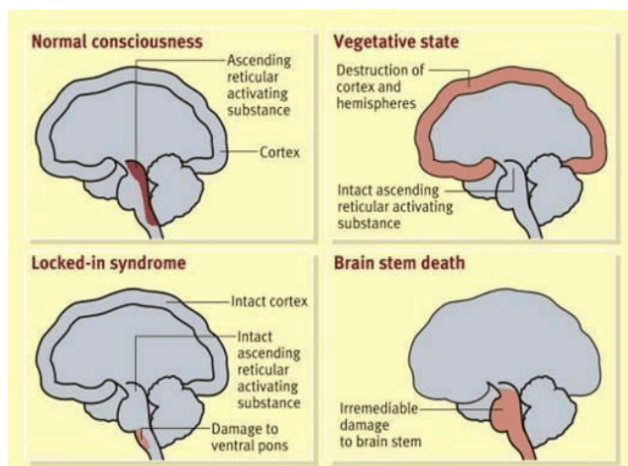


Fig. 3: EEG pattern in coma shows burst suppression, indicating brain dysfunction.

➤ Though fictional, Cook's patients represent a medically plausible scenario — irreversible coma due to hidden cellular insult.

6. Clinical Insight: Why Understanding Cellular Breakdown Matters

➤ Understanding coma at the biochemical level helps guide:

- Early intervention (e.g., correcting hypo-glycemia or hypoxia)
- Neuroprotective strategies (e.g., antioxidants)
- Prognosis evaluation (EEG, biomarkers)

➤ Research continues into mitochondrial stabilizers, ion channel blockers, and glial-targeted therapies to halt or reverse early cellular fallout.

Conclusion:

➤ Coma is not merely a clinical diagnosis- it is the final common pathway of complex cellular failures. From mitochondrial collapse to ion imbalance and synaptic silence, coma reflects the ultimate fallout from disrupted physiology.

➤ Robin Cook's *Coma* may be fiction, but it dramatizes a reality: when the cell fails, the mind disappears. For students of physiology and biochemistry, the journey from function to fallout is more than academic it is the foundation of life, consciousness, and clinical decision-making.

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Cancer Biochemistry

By Shaikh Alfina Noor

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Introduction:

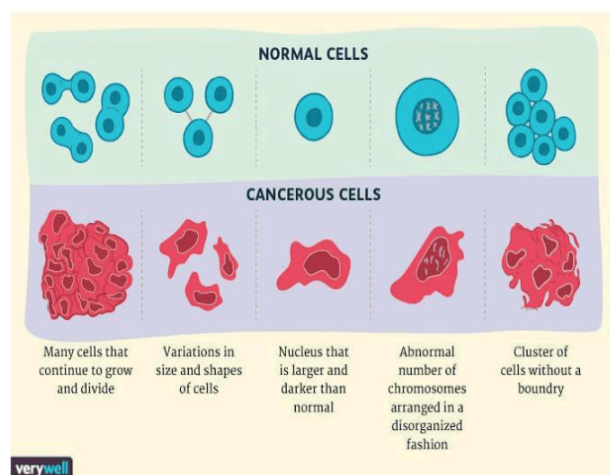
Cancer is one of the most complex and devastating diseases affecting humans. It is not a single disorder but a collection of diseases characterized by uncontrolled cell growth, evasion of programmed cell death, and the ability to invade and metastasize to distant tissues. The foundation of cancer lies in biochemical and molecular alterations that disturb normal cellular homeostasis. Understanding the biochemistry of cancer is essential for unraveling its pathogenesis, developing biomarkers, and designing effective therapies.

Biochemical Basis of Cancer:

At the core of cancer is a disruption of normal biochemical signaling pathways that regulate cell growth, division, and survival. In healthy cells, tightly regulated molecular mechanisms ensure a balance between proliferation and apoptosis. Cancer cells break these regulatory networks, often through mutations in key oncogenes and tumor suppressor genes.

Oncogenes such as *RAS*, *MYC*, and *HER2* encode proteins that promote cell proliferation. Mutations or overexpression of these genes lead to constitutive activation of signaling cascades.

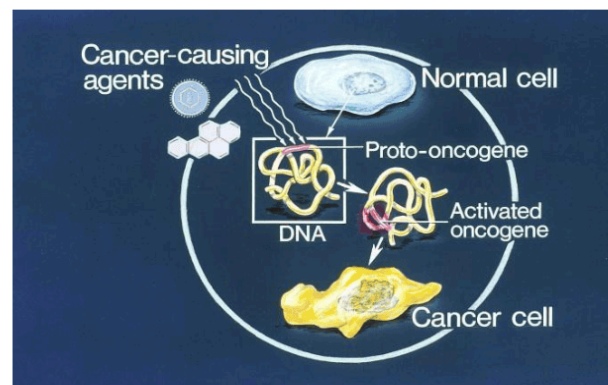
Tumor suppressor genes, like *p53*, *RB1*, and *BRCA1/2*, normally act as brakes by halting the cell cycle or promoting DNA repair. Their inactivation removes critical checkpoints, allowing cells with damaged DNA to survive and divide.



Metabolic Reprogramming in Cancer Cells:

One of the hallmarks of cancer is metabolic reprogramming. Unlike normal cells, which primarily use oxidative phosphorylation in the mitochondria to generate energy, cancer cells often rely on glycolysis even when oxygen is abundant. This phenomenon, known as the Warburg effect, allows cancer cells to

rapidly produce not just energy but also building blocks for DNA, RNA, and lipids that are essential for uncontrolled cell division. Furthermore, cancer cells hijack nutrient pathways. They increase glucose and glutamine uptake to sustain their rapid growth, creating a biochemically distinct environment compared to healthy tissue. This difference is so pronounced that it forms the basis of diagnostic tools like PET scans, which detect high glucose uptake in tumors.



The Role of Signaling Pathways:

Cancer biochemistry is also intricately tied to cell signaling pathways. Growth factors, hormones, and intracellular messengers communicate biochemical signals that regulate survival, proliferation, and death. In cancer, these pathways are often hijacked.

For example:

- (1) The PI3K/AKT/mTOR pathway is frequently overactivated, promoting cell growth and survival.
- (2) The RAS pathway, when mutated, drives unchecked proliferation.
- (3) Altered p53 function, a crucial tumor suppressor, impairs the cell's ability to undergo apoptosis (programmed cell death).

These biochemical disruptions allow cancer cells to become virtually immortal, evade immune detection, and resist therapies.

Advances in Cancer Biochemistry Research:

Targeted therapies:

Instead of indiscriminately killing dividing cells (as in chemotherapy), modern drugs target specific molecules altered in cancer. For example, Imatinib (Gleevec) specifically inhibits the BCR-ABL fusion protein in chronic myeloid leukemia.

Epigenetics: Beyond DNA mutations, biochemical modifications like DNA methylation and histone acetylation can switch genes on or off, contributing to cancer. Drugs that reverse these changes are now in clinical use.

The Future of Cancer Biochemistry:

Biochemistry provides a window into the inner workings of cancer, and future research is poised to transform how we prevent and treat the disease. Personalized medicine, where treatments are tailored to an individual's unique biochemical profile, is becoming a reality. Advances in CRISPR gene-editing, nanotechnology-based drug delivery, and liquid biopsies (detecting tumor-derived molecules in blood) are all rooted in biochemical insights.

The integration of artificial intelligence with biochemical data is another promising frontier, helping scientists decode complex molecular interactions faster than ever before.

Conclusion:

Cancer is not merely a medical condition but it is a biochemical puzzle. Every mutation, every altered pathway, and every shift in metabolism paints a part of the larger picture. By understanding these molecular underpinnings, scientists and doctors are steadily moving closer to conquering cancer.

While challenges remain, the study of cancer biochemistry has already given rise to lifesaving therapies and diagnostics, offering hope to millions. In many ways, cancer research represents the ultimate union of science and humanity: decoding life at its most fundamental level to preserve it at its most precious.

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→ Free access to biomedical literature — search terms like "*cancer biochemistry review*" or "*tumor metabolism*".

Exploring The Mechanisms of Cellular Signal Transduction Pathways & Their Implications for Diseases

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Introduction:

Continuously exposed to external stimuli, such as hormones, growth factors, and neurotransmitters, which can influence the behavior of cells

[1] Through cellular signal transduction pathways, which enable cells to detect and respond to these external stimuli, cells communicate with their environment. The fundamental mechanism of cellular signal transduction pathways is the secretion of signaling molecules by the signaling cell, which bind to specific receptors on the target cell's surface.

This binding initiates a signaling cascade, which results in a variety of cellular responses. Through a literature review, this paper investigates the fundamental mechanisms underlying cellular signal transduction pathways, including intracellular signaling cascades and the functions of various signaling molecules. In addition, the paper examines the various categories of signaling pathways, including G protein-coupled receptors, receptor tyrosine kinases, and nuclear receptors. Understanding the mechanisms of cellular signal transduction pathways can have substantial implications for the development of new treatments for a variety of diseases.

Mechanisms of cellular signal transduction pathways:

Intracellular signaling cascades

[1] Frequently, the complexity of cellular signal transduction pathways results in the formation of intricate signaling networks. Cross-talk between distinct signaling pathways has been observed in numerous systems and has been shown to result in intricately patterned cell responses to various stimuli. Integration and amplification of complex signals improve the accuracy of cellular responses and enable cells to respond to a wide variety of signals with varying intensities.

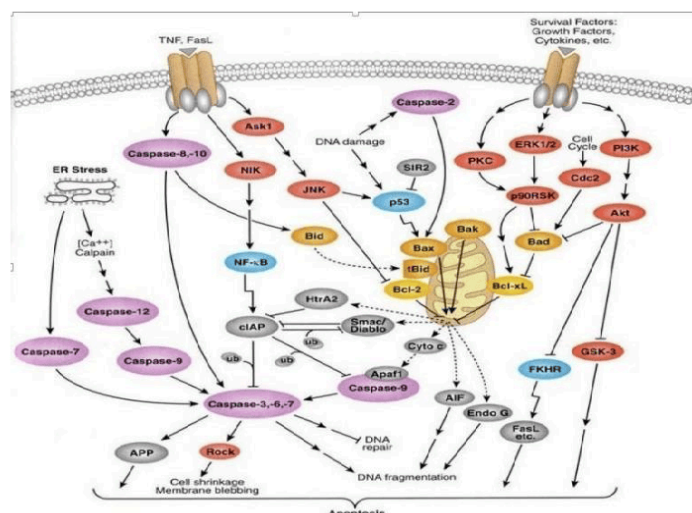
The spatial organization of signal transduction pathways is indispensable for their correct operation. For precise phosphorylation events, the proximity of protein kinases to their substrates, for instance, is crucial. The human genome's protein kinase complement provides an unprecedented view of conserved signaling families and reveals extensive kinome-level diversity

[2]. Through the formation of complexes, scaffold proteins aid in the organization and localization of signaling molecules by ensuring efficient and coordinated signaling events. The multiple protein-protein interaction domains of scaffold proteins that recruit signaling components and coordinate signaling events.

[3] Serve to organize and regulate signaling complexes. Signaling complexes within cells are dynamic entities that can swiftly adapt to changing environments, allowing them to respond optimally to a variety of stimuli.

Numerous diseases can be caused by disruptions in cellular signal transduction pathways. Numerous genetic defects in genes encoding signaling molecules, for instance, have been associated with developmental disorders and malignancies. Inappropriate activation of pathways involved in inflammation and immunity frequently results in autoimmune and inflammatory conditions. Numerous medications used for the treatment of disease modulate intracellular signaling pathways to restore normal signaling, thereby preventing or ameliorating pathological processes.

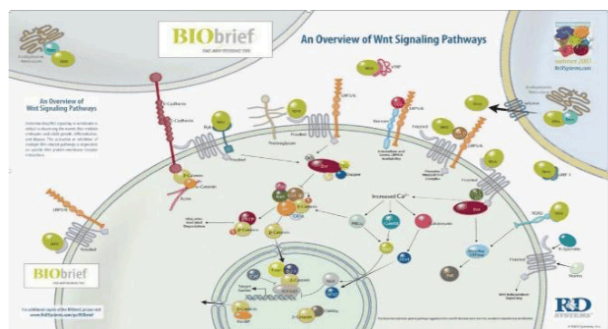
Cellular signaling pathways are crucial to maintaining physiological mechanisms and developing new treatments for a wide range of human diseases. Signal transduction pathway research improves our understanding of cell-environment interactions and may improve human health.



Signaling molecules:

Cellular signal transduction pathways are intricate networks of signaling molecules that enable cells to communicate with one another, respond to environmental stimuli, and regulate diverse cellular processes including growth, proliferation, differentiation, and apoptosis. Various cellular processes, including metabolic homeostasis, neurotransmitter release, and gene expression, are regulated by second messengers, such as cyclic AMP. Cyclic AMP, for instance, activates protein kinase A (PKA), which regulates carbohydrate and lipid metabolism, cell proliferation, and ion channel activity.

Extracellular signals control cell proliferation, differentiation, and death via MAPKs. MAPKs regulate transcriptional activation, mRNA stability, and protein translation via several proximal signaling pathways, including receptor tyrosine kinases and G protein-coupled receptors. MAP kinase cascade signal transduction pathways govern growth, differentiation, and apoptosis. Transcription factors regulate gene expression via promoter DNA sequences. Transcription factor dysregulation can cause cardiovascular, Alzheimer's, and cancer. NF- κ B, which is activated by bacterial and viral infections, is crucial to innate immunity and inflammation. NF- κ B dysregulation causes several inflammatory and autoimmune disorders.



Conclusion:

Numerous physiological processes, including growth, differentiation, proliferation, and apoptosis, are regulated by the complex and interconnected signal transduction pathways in cells. These signaling pathways allow cells to communicate with one another and modulate their response to a variety of extracellular stimuli, including hormones, growth factors, and neurotransmitters.

For instance, the insulin signaling pathway is essential for regulating glucose homeostasis, protein synthesis, and cell growth. Insulin binding to its receptor results in the autophosphorylation of a number of intracellular substrates, which in turn activates signaling molecules downstream. This pathway's dysregulation has been linked to numerous diseases, including diabetes and cancer.

Similar to Wnt (wingless-related integration site) signaling, embryonic development, tissue homeostasis, and stem cell maintenance all entail a complex pathway. The diverse functional roles of the various components of the Wnt pathway have been intensively studied by, among other conditions, bone disease, cancer, and neurological disorders.

In the study of cellular signal transduction pathways, numerous methods have been employed, ranging from genetic engineering technologies to advanced imaging techniques to map the interactions between signaling molecules. These investigations contributed to the creation of novel drug targets for diseases involving modifications in signal transduction pathways. For example, protein kinases, a crucial component of cellular signaling pathways, have become a significant focus in cancer drug development, resulting in the creation of molecularly targeted cancer therapies.

As our comprehension of these intricate pathways continues to expand, scientists are able to identify novel therapeutic targets and devise new treatments for a wide variety of diseases. A comprehensive understanding of signaling pathways, their components, and crosstalk mechanisms is also required to comprehensively investigate the biological operations of living systems, paving the way for significant scientific discoveries and technological advances [8]. Technological advances in the search for kinase substrates have the potential to reveal novel signaling pathways and therapeutic targets for a wide variety of human diseases.

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Role of Volatile Compounds in Plant Communication

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Introduction:

Plants are sessile organisms and thus must perceive their surrounding environment precisely and timely for survival. Plant hormones are internal chemical signals communicating changes in the external environment to cell, tissue, and organ levels. At the same time, volatile compounds act as a language that plants use to communicate with other species and individuals of the same species. Plant volatiles are a complex mixture of organic compounds constituting about 1% of plant secondary metabolites with a molecular weight lower than 300 Da. Over 2000 volatile compounds have been characterized from different plant families. Plant volatiles can be emitted from leaves, fruits, flowers, and roots (Venkatesan, 2015).

Classification and biosynthetic pathway:

Volatile organic compounds (VOCs) produced by plants aboveground are dominated by four chemical families originating from the following biosynthetic pathways: terpenoids (mevalonic acid [MVA] and methylerythritol phosphate [MEP] pathways); fatty acid derivatives (lipoxygenase [LOX] pathway); benzenoid and phenylpropanoid compounds (shikimic acid pathway); and amino acid derivatives Maffei (2010).

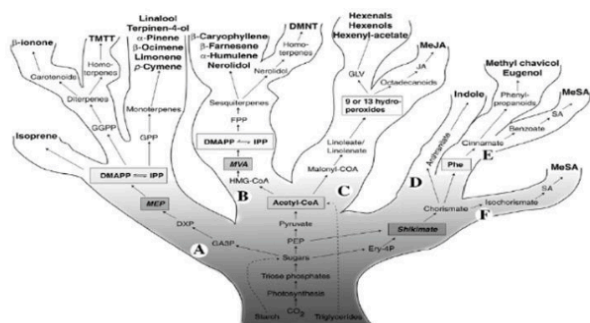


Fig. 1 The volatilome tree. VOCs are produced through various pathways viz. MEP, MVA, LOX and shikimate [Adapted from Maffei (2010)]

Plant- plant interactions:

Volatile cues are information used by a receiver that is not intentionally released by emitters. Constitutively

released volatile cues provide information about the genetic identity of plants, which are used by individual plants in the process of detection, discrimination and adaptation to competitive neighbours. Volatile signals are intentionally released as a result of the emitters response to external events with the aim of communicating with the receiver for specific purposes (Ninkovic *et al.*, 2021).

VOCs perception:

The perception of VOCs in plant occurs through 1) the presence of odorant-binding proteins (OBPs) as odor transporters and the presence of olfactory receptors (ORs) that receive the VOCs, transduce the chemical signal, and generate the response of the plant 2) by binding of VOCs directly to the ORs, which again induces a change in OR conformation and generates a plant response through the transduction of a chemical signal 3) by binding VOCs directly onto the cell membrane (Loreto and D'Auria, 2022).

Role of VOCs:

The primary function is to mediate interactions with mutualists such as beneficial microbes, pollinators and seed dispersers, while another function is to deter harmful interactions with herbivorous insects or pathogens [E.g. i) Flowers emit VOCs like aliphatics, benzenoids, phenyl propanoids, monoterpenes, sesquiterpenes to attract pollinators; ii) Chewing herbivores like *Spodoptera littoralis* induce the plant emissions of several monoterpenes, sesquiterpenes and homoterpenes that attract predatory wasps] (Ninkovic *et al.*, 2021).

Agricultural importance of volatile compounds:

VOCs prime plant's defense mechanisms for an enhanced resistance/tolerance to the upcoming stress, quench reactive oxygen species (ROS), have potent antimicrobial as well as allelopathic effects and might be important in regulating plant growth, development and senescence through interactions with plant hormones (Brilli *et al.*, 2019).

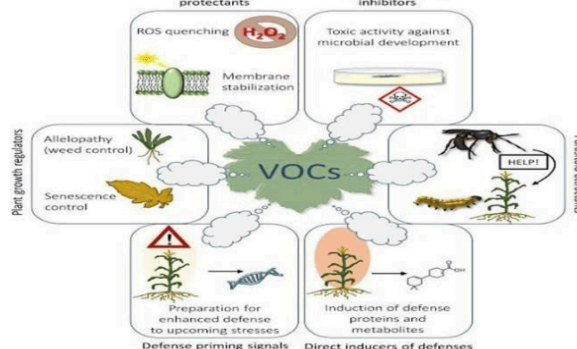


Fig. 2: Possible applications of plant VOCs in agriculture [Adapted from Brilli *et al.*, 2019]

VOC Class	Biochemical pathway	Biosynthetic site (Tissue types)	Defense compound name; Constitutive(C), Induced (I)	Infochemical interactions
Hemiterpene	MEP	Chloroplast (mesophyll cells)	Isoprene (C,I)	Thermotolerance. Tolerance of reactive oxygen species.
Monoterpene	MEP	Glandular trichomes, mesophyll wounded tissues, chloroplasts	Linalool (C, I)	Repels aphids. Electrophysiologically active compound. Alarm pheromone inhibitor.
Sesquiterpene	MVA	Root secretory cells	Vetiverol (C, I)	Produced in root cells upon bacterial transformation. Toxic to insects and mammals (rats, mice and rabbits).
Fatty acid derivatives, GLV	Oxylipin pathway	Herbivore and microbe wounded tissues	Hexenyl-acetate (I)	Increases in response to insect feeding.
Jasmonates	Oxylipin pathway	Secretory tissues, herbivore wounded tissues	Methyl jasmonate (C, I)	Released in response to wounding and herbivore attack
Phenylpropanoids	Shikimate pathway	Glandular trichomes and other secretory structures	Eugenol (C, I)	Produced by plants as defense compound against animals and microorganisms and as floral attractants of pollinators. Larvicidal activity against tobacco armyworm, <i>Spodoptera litura</i>

Table 1: Selected Examples of the Functional Role of Plant Volatilome [Adapted from Maffi[2010]

Conclusion:

In nature, plants continuously interact with other living organisms that share their environment, notably via the synthesis and release of volatile organic compounds. The volatiles are mainly represented by terpenoids, phenylpropanoids/benzenoids, fatty acid and amino acid derivatives. Neighbouring plants use VOC cues and signals to compete for limited resources, enhance direct resistance against herbivores, microbes and fungi, or to attract predators. The complex dialogue between the emitter and receiver based on either volatile cues or signals determines the outcome of information exchange, which shapes the communication pattern between individuals at the community level and determines their ecological implications at other trophic levels. The primary functions of airborne volatiles are to defend plants against herbivores and pathogens or to provide a reproductive advantage by attracting pollinators and seed dispersers.

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Dance of Molecules in Cancer and Stress

Author – Dr. Vishal Nanavaty

Alumini

Correct the Stage:

The Central Dogma of Life, the flow of genetic information (in a direction) from the Deoxyribonucleic acid (DNA) to the Ribonucleic acid (RNA) to protein in all living organisms, was first proposed by Dr. Francis Crick. In a deeper sense, biomolecules convey biological information, only in one direction, to achieve the physiological outcome of the cell. In today's times, cancer falls in the category of a treacherous disease, causing trouble to millions of lives, while stress, the number will be in billions. To live happily and healthily, people engage in various entertaining activities, such as reading, exercising, traveling, binge-watching favorite shows, listening to music, dancing, and many more. Similarly, biomolecules like DNA, RNA, and Proteins also dance inside the cell to create a perfect environment for all the different cellular activities.

Finding the rhythm 1, 2, 3, 4 & repeat.

It all starts within the nucleus when the DNA decides to replicate, stalling the cells at the "S-phase" of the cell cycle. DNA polymerase (telomerase, specifically for the telomere ends of chromosomes) is the enzyme that creates the first rhythm to preserve the genetic information present in one cell and triggers the signals for the cell's propagation into meiosis/mitosis. For the second rhythm, the process of transcription, the RNA polymerases decipher the code written on DNA molecules. It is divided into three phases: initiation, elongation, and termination. Transcription termination is triggered once RNA polymerase passes by polyA signals and matures to proximal (short) or distal (long) RNA molecules. The third rhythm of biomolecules is triggered when mRNA is exported and has reached the endoplasmic reticulum to meet ribosomes and has RNA into the perfect harmony of proteins. The fourth rhythm initiates when the Golgi bodies ensure the protein folding, and deformed proteins undergo the process of proteolysis. In cancer cells, these rhythms can be affected at any stage, supporting the increased cell growth, especially under stress. Depending on the type of stress, it either increases or decreases the pace of any of the four rhythms.

Disruption of Rhythms in Cancer and Stress:

DNA methylation (DNAm), a modification at the 5th carbon on cytidine, is a known epigenetic mark that has the potential to be transferred across generations. It has the power to deflect all four rhythms systemically.

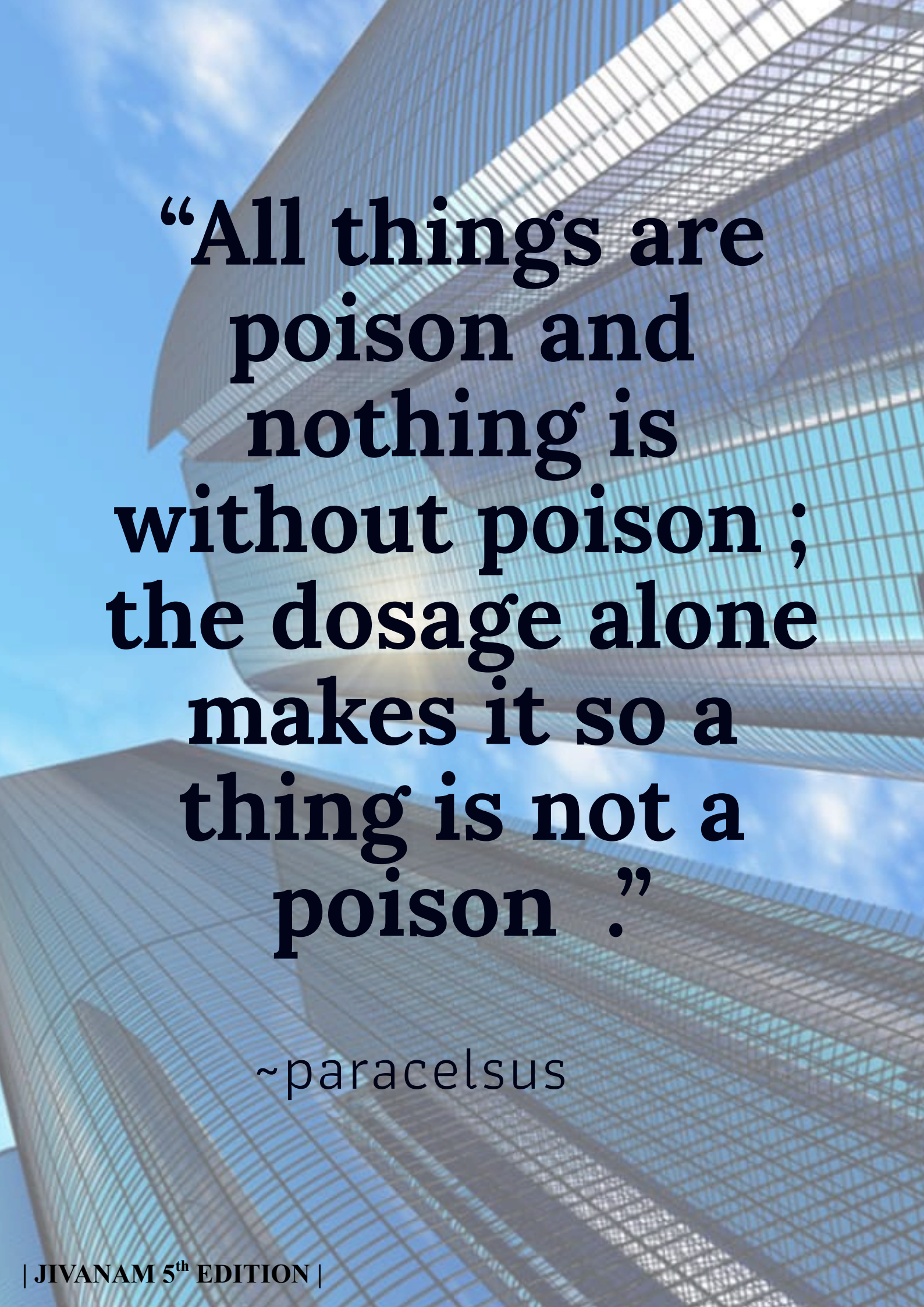
DNAm is known to repress the transcription of downstream genes when it is majorly found at the promoter region of the DNA. Alternative polyadenylation (APA) is another well-known scenario where transcripts can be abruptly terminated or increase the length of the DNA region transcribed. If the transcript passes by the first observed polyA signals, then the product is known as the distal product and will be produced with full-length protein, while the transcripts that get terminated at the polyA signals are known as the proximal ones.

Recently, it has been described in the colon cancer cell line models that there is a DNA methylation signature present between the two polyA sites, which leads to a closed loop formation using proteins involved in chromosome architecture maintenance, such as cohesin complex and the famous CCCTC-binding factor (CTCF). The closed loop generated by these complexes causes RNA polymerase to stall at the site, leading to premature transcription termination and hence increasing the production of short transcripts. The switch tends to be because of DNA methylation, and the same was demonstrated with the help of removing CTCF binding sites using CRISPR/CAS9. Hence, in the cancer condition, the short transcripts are found to act on the target by stabilizing oncogenes and/or reducing the expression of tumour suppressor genes.

A similar mechanism acts differently in the stress condition. The heatshock is a well-known scenario where the chaperon proteins control the fate of the proteins and proteostasis. The target gene, such as DNAJB6, which undergoes isoform production from a long transcript to a short one, upon a small heat shock, a proximal isoform is aggregated, ultimately preventing protein aggregation in the cell and thus allowing the cells to survive in the heat shock conditions. The beauty of the cells was such that the minor heatshock, for up to 4 hour reduced the complete formation of the protein DNAJB6 by 6-fold. The ultimate cause of the reduction was deduced to be that a short heat shock reduced the presence of DNAm on the APA controlling region of the gene DNAJB6.

Conclusion:

The two experiences that are studied within the same mechanism but in a different physiological scenario remind us about the flexibility of the biomolecules and their ability to adapt to the rhythms provided by nature. On a lighter note, one must remember that it is a Garba, Bhangda, Bharat Natyam, or Katthak, rhythms are important, but based on the stage and audience, performances are different.



**“All things are
poison and
nothing is
without poison ;
the dosage alone
makes it so a
thing is not a
poison .”**

~paracelsus

Latest Discovery of Biochemistry in 2025-26

Sr. No.	Discovery	Description	Impact	Year
1	Quantitative Enzyme Mechanism Mapping	Stanford researchers captured > 1000 XRay Structural Snapshot showing how enzyme achieve extreme catalytic rates, offering a quantitative model for enzyme function	Leads to enhanced enzyme design for industry & therapeutics; deepens understanding of biochemical catalysis	2025
2	AI-Driven Protein Structure insights & Novel linkages	Machine model like ProtGPS and other uncovered hidden sequence patterns and new nitrogen-oxygen sulphur linkages in proteins, refining structural predictions.	Advance Protein designs, Drug discovery and understanding of cellular process.	2025
3	Protein Degradation Control via PROTACs	New Biochemical strategies to selectively destroy disease-causing proteins.	Breakthrough in cancer and neurodegenerative disease therapy.	2025
4	Single-Cell Metabolomics	High resolution metabolites mapping in living cell	Enhance understanding of cancer and stem cell metabolism.	2025
5	CRISPR- Based Epigenetic Editing	Precise modification of gene expression without DNA Cleavage	Safer gene therapies and disease control	2025

Latest Discovery of Biochemistry in 2025-26

Sr. No.	Discovery	Description	Impact	Year
6	Mitochondrial Metabolic Reprogramming	Discovery of new regulators controlling mitochondrial energy output.	Promising therapies for obesity and metabolic disorders.	2026
7	Radical Enzymes in Neurochemistry	Controlled radical reactions essential for brain development identified.	Improves understanding of neurological disorders.	2026
8	Enzyme Catalysis at Atomic Resolution	Time-resolved crystallography revealed real-time enzyme-substrate interactions.	Improves industrial enzymes and pharmaceutical synthesis	2025
9	Human Queuosine Transport Gene Identified	Scientists discovered the specific gene (SLC35F2) that enables the cellular uptake of queuosine, a crucial micronutrient involved in protein translation.	Opens new therapeutic avenues related to cancer brain function and nutrition.	2025

Latest Discovery of Biochemistry in 2025-26

Sr. No.	Discovery	Description	Impact	Year
10	Controlled Protein Synthesis in Microfluidic Systems	Researchers developed methods to spatially organise cell-free protein synthesis within microfluid setups, enabling more precise molecular control.	Offers tools for synthetic biology and building life-like systems from basic components.	2025
11	Chirality Emergence in Metabolic Networks	New theoretical work shows how metabolic networks may have driven chiral molecule selection early in evolution.	Helps bridge origins of life science with biochemical design principles.	2025
12	Cell-Free Synthetic Biochemistry Systems	Artificial biochemical pathways constructed outside living cells.	Enables sustainable biochemical manufacturing.	2025
13	Infrared Microscopy of Single Cell Biochemistry	Advances in IR microscopy now allow real-time biochemical and metabolic insights at the single living cell level.	A powerful tool for metabolomics, drug testing and cell physiology research.	2025
14	Mitochondria-Boosting Metabolic Enhancers	Scientists developed experimental drugs that increase mitochondrial activity to burn more calories.	Potential new treatments for obesity and metabolic disorders.	2025

Latest Discovery of Biochemistry in 2025-26

Sr. No.	Discovery	Description	Impact	Year
15	Molecular "Reshuffle" Achieves Chirality Control	University of St Andrews uncovered a molecular mechanism addressing long-standing challenges in chiral control, with implications for drug manufacturing.	Could change how chirality is managed in pharmaceuticals and materials.	2026
16	Chirality Origin in Biomolecules	Biochemical pathways explaining molecular handedness discovered.	Advances origin-of-life and pharmaceutical research.	2026
17	Enzyme Radical Control in Brain-Building Chemistry	Collaborative research revealed how radical-generating enzymes initiate safe, controlled reactions relevant for complex biological synthesis.	Enhances drug manufacturing and understanding of essential biochemical pathways.	2025

Unravelling the Body's Peace keepers : The 2025 Nobel Prize in Medicine or Physiology & Secret of Immune Tolerance

“The immune system is a miracle of evolution- an orchestra of cells and molecules that together maintain the integrity of the self”- Frank Macfarlane Burnet (Nobel laureate, 1960).

Introduction:

What happens when your body's defence system forgets who the real enemy is? Every moment our immune system works silently identifying threats and defending us from countless invaders. Yet in this complex process one wrong signal could turn the body's defences against itself causing it to attack its own tissues.

A special group of immune cells called Regulatory T cells also known as Tregs, together acts as a body's peacekeepers which ensures that our immune system attacks only what it should be. Therefore The Noble Assembly held at Korolinska Institute awarded the 2025 prize jointly to MARY E. BRUNKOW, FRED RAMSDELL, SHIMON SAKAGUCHI for their ground-breaking discoveries in regulation of immune tolerance through regulatory T cells [Tregs] and Foxp3 gene. Findings explain how our immune system learns to tolerate self and prevent the auto immune chaos.

The Scientists Behind The Discovery:

LAUREATE	NAME	AFFILIATION	KEY DISCOVERY
	Shimon Sakaguchi	Osaka University, Japan	Discovered Regulatory T- cells (Tregs) in 1995, identifying them as security guards of the immune system.
	Fred Ramsdell	Sonoma Biotherapeutics, U.S.A	Identified the Foxp3 gene as the master regulator for Treg development and function.
	Mary Brunkow	Institute of System Biology, U.S.A	Proved that mutation in Foxp3 gene can lead to severe, fatal immune disorders in both mice and humans.

Scientific Importance:

The regulatory T cells controlled by foxp3 gene which keeps our immune system undercheck throughout life. These cells act as brakes of immunity ensuring that our body fights infection but doesn't harm its own tissues. Their research proved that tolerance is not just absence of attack but not an active process. When those Treg cells or FOXP3 gene don't work properly, the body starts attacking itself, which leads to autoimmune disease.

This discovery linked genetics, cell biology and medicine opening new ways to treat autoimmune diseases, control transplant rejection and even improve cancer therapy.

Medical Applications of Treg Research:

Field of Medicine	Mechanism and application	Goal
Organ Transplantation	Using Tregs help the immune system accept a foreign organ more peacefully.	To reduce the need of strong immunosuppressive drugs and their side effects.
Cancer Treatment	Study how to block Tregs, which normally suppress immune cells too much and protect the Cancer cells.	To help the body's natural defence fight cancer more effectively.
Autoimmune diseases	Fixing the brakes when the Foxp3 gene stops working.	To stop the body attacking its own tissues in diseases like Type 1 Diabetes or rheumatoid arthritis.

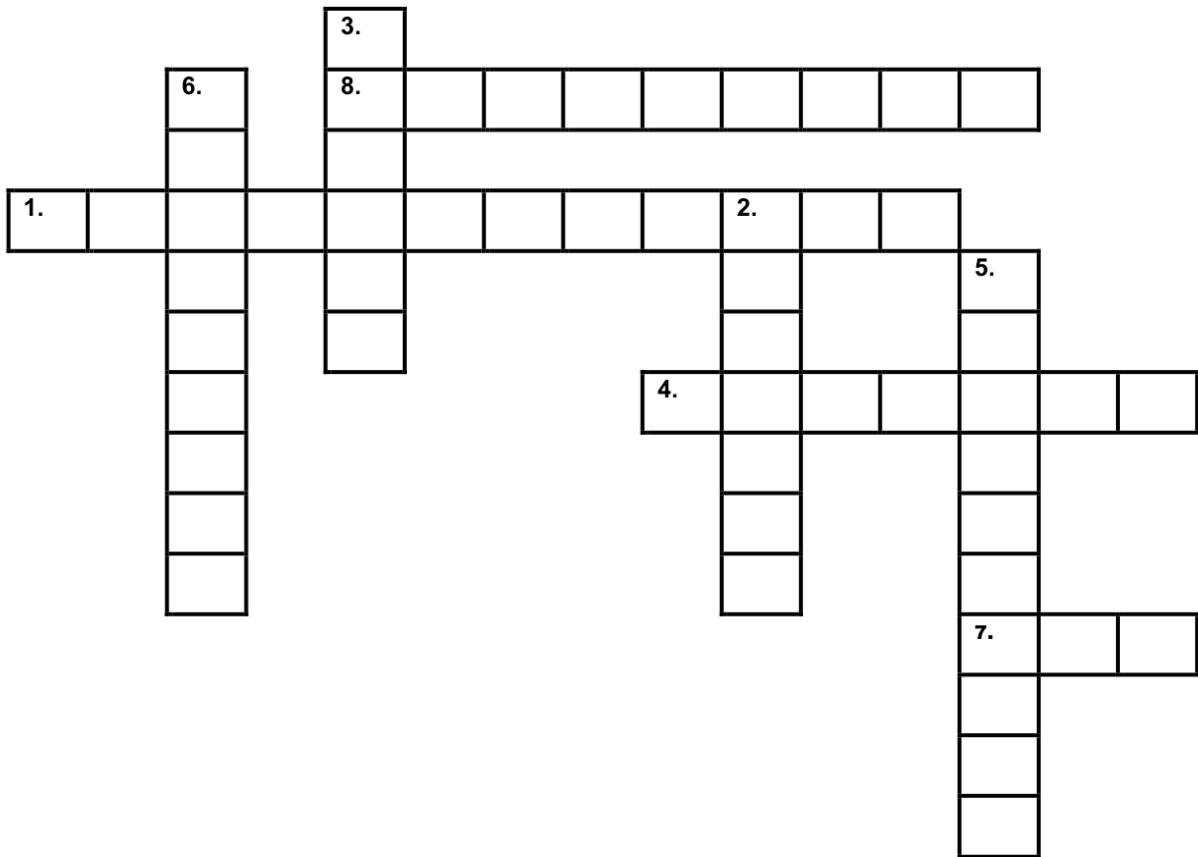
References:

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2. Davidson, A., & Diamond, B. (2001). "Autoimmune diseases." New England Journal of Medicine, 345(5), 340–350.
3. Klein, L., Kyewski, B., Allen, P. M., & Hogquist, K. A. (2014). "Positive and negative selection of the T cell repertoire: what thymocytes see (and don't see)." Nature Reviews Immunology, 14(6), 377–391.
3. Nobel Prize. (1960). The Nobel Prize in Physiology or Medicine 1960 — Burnet and Medawar: Acquired Immune Tolerance. Retrieved from <https://www.nobelprize.org/prizes/medicine/1960/summary>
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Thinkplasm

Crossword Puzzle

Solve the crossword by reading the clues below.



ACROSS

- 1.** Organelle that generates cellular energy through respiration.
- 4.** Process by which cells divide to form identical daughter cells.
- 7.** Genetic material carrying instructions for protein synthesis.
- 8.** Programmed cell death essential for development and balance.

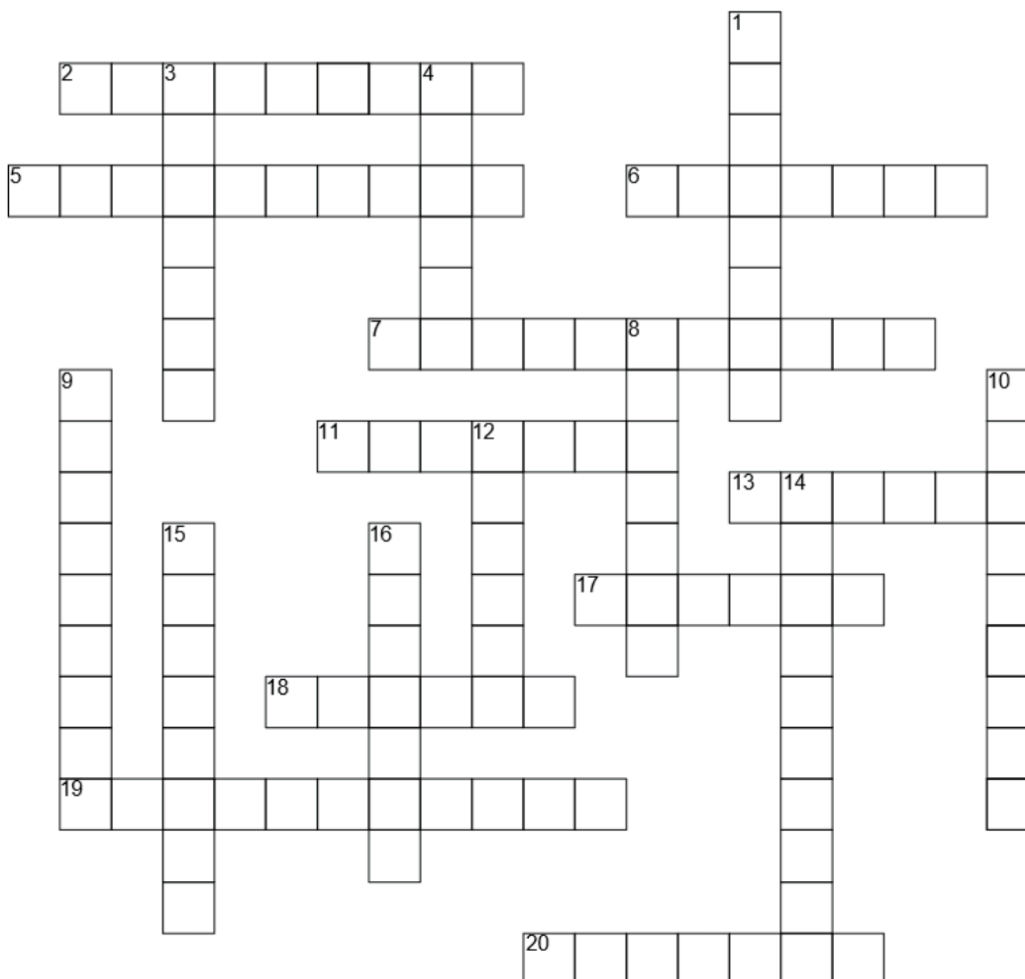
DOWN

- 2.** Chemical produced during metabolism that can damage cells.
- 3.** Failure of cellular control leading to uncontrolled division.
- 5.** Folding error in proteins linked to neurodegenerative diseases.
- 6.** Cellular mechanism that removes damaged organelles.



CROSSWORD PUZZLE

READ THE CLUES BELOW AND FILL IN THE GRID



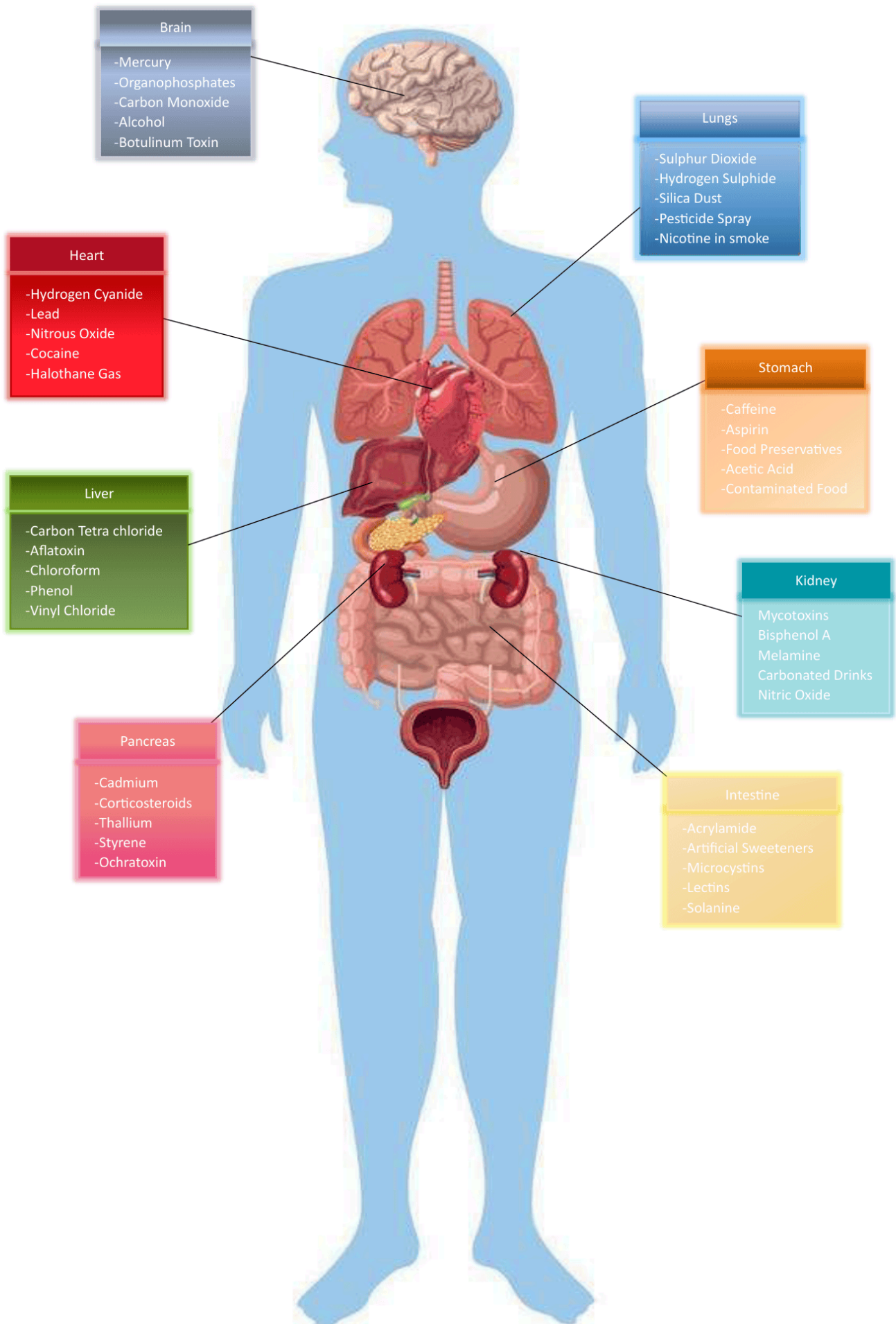
ACROSS

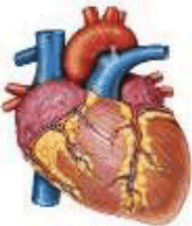
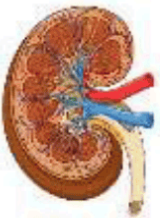
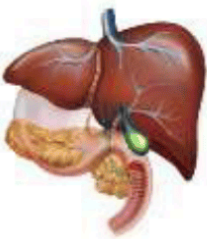
2. polysaccharide that makes up plant cell walls
5. the----- group participates in reactions
6. type of compound that has a hydroxyl group(-OH)
- 7.gives structure and integrity to cell membrane
- 11.a common monosaccharide
13. polysaccharide that forms exoskeletons
17. fatty acids; waxes, oils and fats
- 18.contains a carboxyl group =C=O ; acetone
19. sugar found in DNA
20. glucose + fructose =

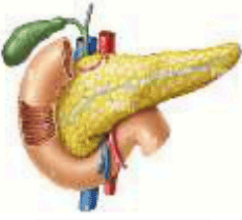
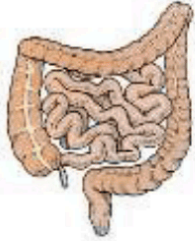
DOWN

- 1.Long chain of glucose; energy storage in animals
- 3.milk sugar
4. long chain of glucose; energy storage in plants
8. type of lipid that has four fused rings; cholesterol
9. type of fat that is solid at room temperature
10. combining molecules by losing water; dehydration---
12. element found in ALL organic compounds
14. chemical breakdown using water
15. isomer of glucose; found in fruit
16. composed of chains of amino acids

Effects Of Toxic Material on a Human Body



Organs	Toxic Effect	Research
 Brain	• Memory loss and impaired learning • Headache and dizziness • Tremors and muscle twitching • Long-term cognitive and neurological deficits • Paralysis	• Microplastic Infiltration • Neurotransmitter inhibition • Blood- Brain Barrier Leakage • Synaptic Plasticity Disruption
 Lungs	• Breathing difficulty and chest tightness • Coughing and lung inflammation • Increased risk of chronic respiratory diseases • Reduced lung function • Irritation of eyes, nose, and throat	• Fine Particulate (PM2.5) Risk • Alveolar Gas Exchange Loss • Pulmonary Fibrosis Pathway • Macrophage Hyperactivation • Epithelial- Mesenchymal Transition
 Heart	• Irregular heartbeat (arrhythmia) • Reduced oxygen supply to heart muscle • Increased blood pressure or sudden drop in blood pressure • Chest pain and palpitations • Decreased cardiac output	• Air Pollution Cardio Toxicity • Cardiac Rhythm Alteration • Myocardial Oxygen Depletion • Endothelial Nitric oxide Suppression • Atherosclerotic Plaque Acceleration
 Kidney	• Damage to kidney tubules and glomeruli • Reduced filtration rate • Proteinuria • Haematuria • Formation of kidney stones • Fluid and electrolyte imbalance	• Heavy Metals Bioaccumulation • Nephron Filtration Failure • Glomerular Oxidative Stress • Tubular Epithelial Cell Necrosis • Electrolyte Reabsorption Disruption • Renin- Angiotensin System Imbalance
 Liver	• Metabolized by cytochrome P450 (CYP2E1) • Stimulates normal hepatic intermediates • Mitochondrial dysfunction • Fibrosis and cancer • DNA-protein damage • Lipid peroxidation injury • Reactive metabolite formation	• PFAS Accumulation effects • Drug Induced Hepatotoxicity • Fatty acid Metabolic Stress • Cytochrome P450 enzyme Dysregulation • Hepatic Fibrosis Pathway Activation • Mitochondrial Dysfunction in Hepatocytes

 Pancreas	• Endocrine signalling disruption • β cell oxidative damage • Insulin synthesis inhibition • Mitochondrial metabolic failure • Pancreatic inflammation fibrosis	• Endocrine Signal Interference • Insulin Secretion Failure • Pancreatic Cell Inflammation • β cells Mitochondrial damage • Glucose- Sensing Mechanism Breakdown
 Stomach	• Gastric acid hypersecretion • Mucosal barrier erosion • Prostaglandin inhibition • Epithelial cell necrosis • Uncreative inflammation risk	• Food Additives toxicity • Gastric Acids disruptions • Mucosal Membrane Necrosis • Helicobacter pylori Colonisation Enhancement • Reactive Oxygen Species Accumulation
 Intestine	• Epithelial barrier damage • Gut microbiota imbalance • Nutrient absorption inhibition • Inflammatory cytokine release • Oxidative stress increase • Immune cell activation • Tight junction disruption • Mucus layer thinning	• Nano plastic Barrier Damage • Microbial Flora Dysbiosis • Intestinal lining Erosion • Tight Junction Protein Degradation • Inflammatory Cytokine Overexpression • Reduced Nutrient absorption efficiency



**Batch
2023-27**



**Batch
2024-28**



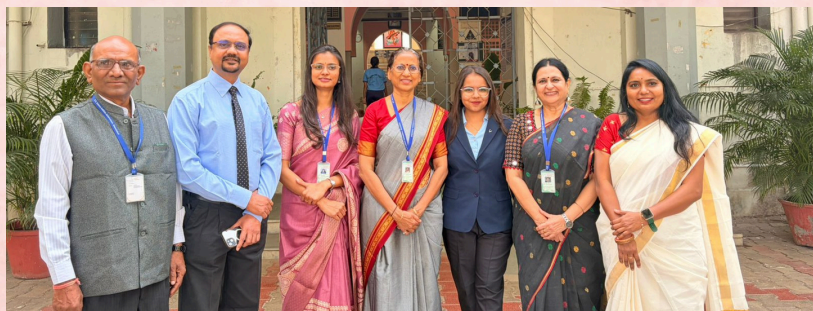
**Batch
2025-29**

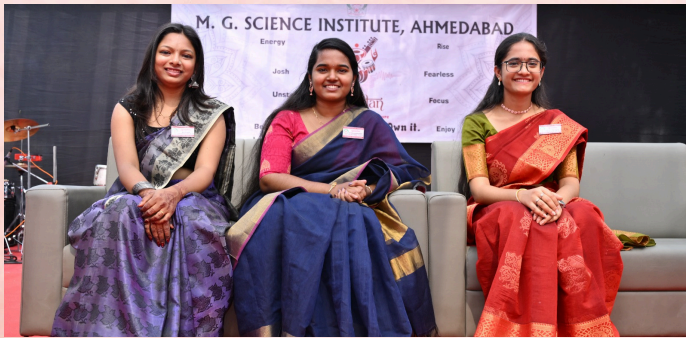


35th ESTABLISHMENT DAY CELEBRATION OF BIOCHEMISTRY DEPARTMENT





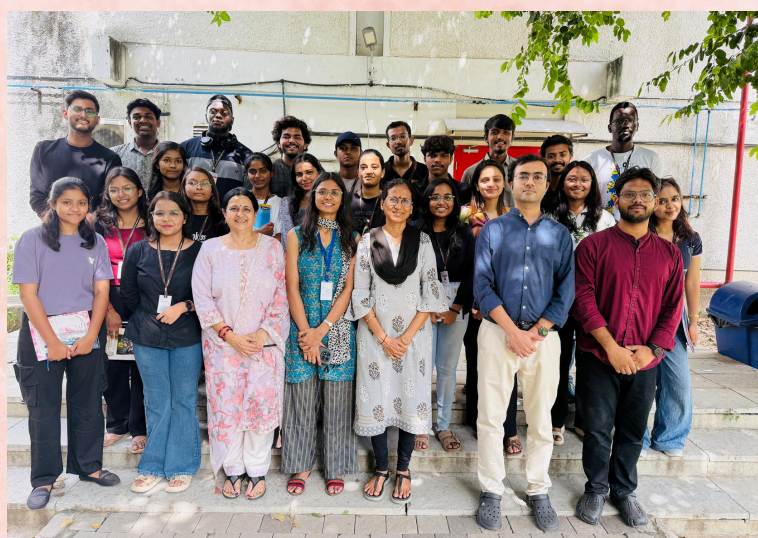




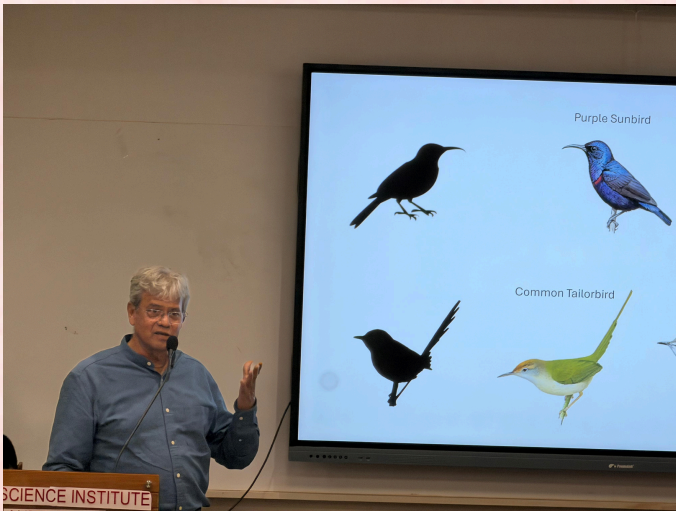




Successful Internship At SBRI



EVENT ON WORLD WETLAND DAY(BCSG)



Note Of Thanks

On behalf of the Editorial Board, it is an honor to present the 5th Edition of our departmental magazine, "JIVANAM." This milestone marks half a decade of documenting the intellectual growth, scientific curiosity, and creative spirit of the Department of Biochemistry.

The creation of this magazine is a collaborative marathon, and we wish to extend our deepest appreciation to everyone who made it possible.

We extend our sincere thanks to the college administration for providing us with the prestigious platform and resources to showcase our department's achievements.

We are profoundly grateful to our esteemed faculty for their unwavering guidance, mentorship, and for fostering an environment where curiosity thrives. Your insights have been the backbone of this publication.

To our talented students, thank you for your vibrant contributions. From insightful research articles to creative expressions, your work reflects the high caliber of our department.

A special note of thanks goes to the Biochemistry Alumni [ABMG] Your continued support and connection to the department serve as a great inspiration to current students. Your legacy is woven into the fabric of this magazine.

We wish to express our deepest gratitude to Rajkumar Vasava sir for his generous sponsorship and contribution for "JIVANAM".

Sir, your unwavering support has been a cornerstone of our success. Your continuous presence and encouragement in the "victory" of this departmental magazine have empowered us to reach new heights. We are truly honored by your commitment to our vision.

As we release this edition of JIVANAM, we celebrate not just a publication, but the bond that holds the Department of Biochemistry together. We hope this edition inspires you as much as it inspired us during its creation.

This magazine is not just a collection of pages, it is a celebration of our department's growth and unity.

With Best Regards,

The Editorial Board,

JIVANAM5.0,

Department of Biochemistry,

M.G. Science Institute

Honouring our Editorial Excellence

As we release JIVANAM 5.0. We acknowledge the remarkable and excellent work of our past editorial board members. Your legacy continues to inspire us, and we endeavor to build upon the foundation you've laid. Thank you for your vision, leadership, and your invaluable contribution to JIVANAM. Thank you for providing the way for us. We appreciate your hardwork and grateful for the opportunity to build upon your success.

Now we would like to acknowledge the following editorial team members who contributed to our previous editions:

1st EDITION: 1) Ritikaba Vaghela (Batch: 2020-23)

2) Avani Parmar (Batch: 2020-23)

3) Aditi Baluni (Batch: 2020-23)

2nd EDITION: 1) Ritikaba Vaghela (Batch: 2020-23)

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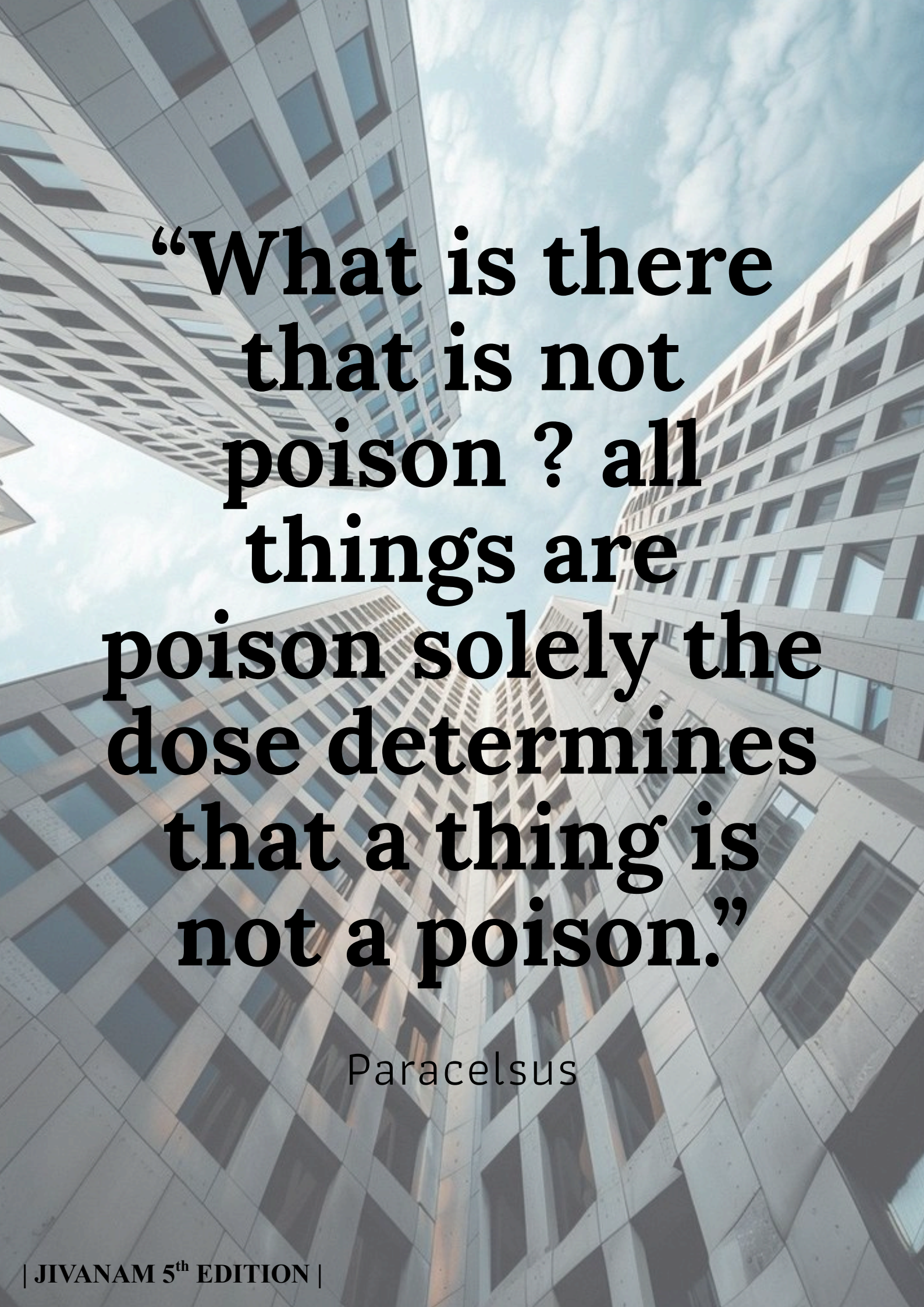
11) Tathya Yagnik (Batch: 2024-28)

12) Harsh Pandya (Batch: 2024-28)

With sincere appreciation,

The Editorial board

JIVANAM 5.0



**“What is there
that is not
poison ? all
things are
poison solely the
dose determines
that a thing is
not a poison.”**

Paracelsus



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Gujarat University, Navrangpura, Ahmedabad

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