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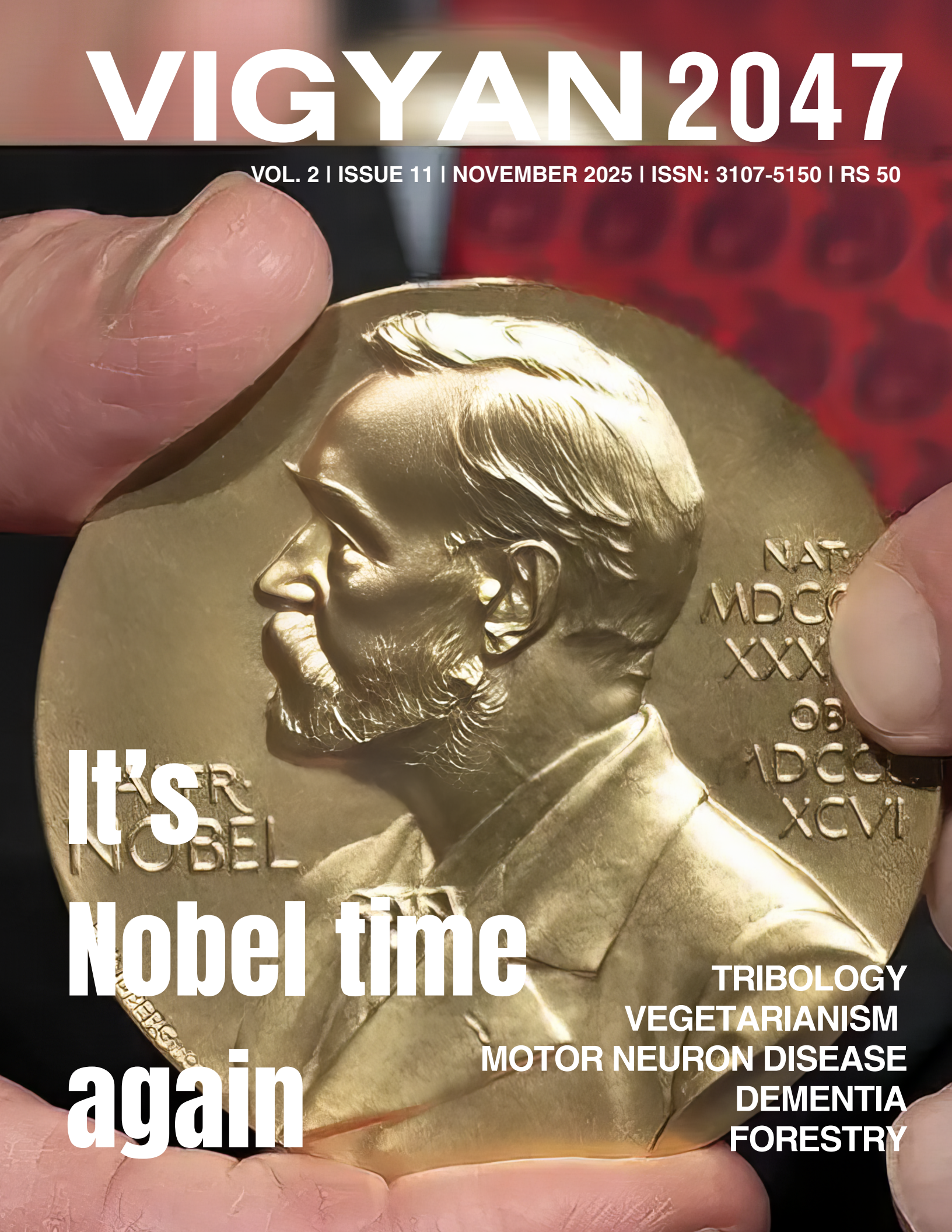

It's Nobel time again

TRIBOLOGY
VEGETARIANISM
MOTOR NEURON DISEASE
DEMENTIA
FORESTRY

VIGYAN 2047

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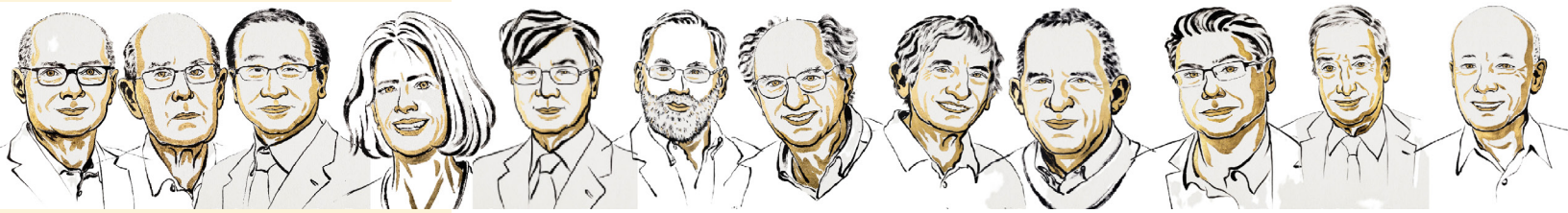
In This Issue



Editorial

The Radiance of Recognition

Each October, when Stockholm and Oslo announce the Nobel Prizes, the world's attention turns briefly and brightly toward science. Laboratories across continents hold their breath, universities polish their press releases, and governments scramble to associate their names with the laureates. For more than a century, the Nobel has stood as the apex of scientific recognition—an emblem of human curiosity and perseverance. Yet behind the golden medallion and the solemn ceremonies lies a complex story: one of extraordinary achievement, but also of systemic blind spots that continue to shape the pace and perception of global science.

At their best, the Nobel Prizes perform an indispensable service—they remind humanity that intellect, imagination, and integrity matter. In an age dominated by markets and machines, the Nobel moment reaffirms that it is ideas, not wealth, that move civilizations forward. The laureates—whether unravelling the mysteries of the cosmos, decoding the architecture of life, or engineering materials that redefine industries—serve as beacons of what disciplined curiosity can achieve.

Yet, for every scientist who walks onto the Stockholm stage, there are hundreds who never even approach its shadow. History is replete with examples of quiet brilliance—researchers who lacked the geopolitical visibility, institutional privilege, or financial scaffolding required to be "seen."

Science does not flourish in isolation; it flourishes where ecosystems support it. Laboratories in developing and under-developed countries face an unending battle against inadequate funding, lack of infrastructure, limited mentorship, and restricted access to journals, equipment, and international collaborations. In such contexts, even a Nobel-worthy idea may languish untested.

It is time to broaden our imagination of what constitutes "great science." The Nobel tradition, though venerable, must evolve alongside the discipline it honors. Global science today is not confined to pristine laboratories of Europe or North America; it pulsates in field stations in Africa, community labs in India, coding hubs in Southeast Asia, and medical research units in Latin America. Recognizing such contributions would not dilute the prestige of the Nobel—it would deepen its moral and scientific legitimacy.

Equally, developing nations must not wait for Stockholm's endorsement to celebrate their own pioneers. Regional prizes, national academies, and international consortia should elevate local achievements to global visibility. When recognition becomes plural and inclusive, science itself becomes stronger, more representative, and more just.

Science is humanity's shared inheritance, not a privilege of geography or language. Every child who wonders, every researcher who persists despite scarcity, and every teacher who ignites curiosity participates in this continuum. The Nobel Prizes will continue to inspire—as they should—but their true worth will be measured not just by who wins them, but by who can aspire to win.

Until a child in a remote laboratory in Africa, Asia, or Latin America feels that same possibility, the promise of universal science remains unfulfilled. The challenge before us, therefore, is not to diminish the Nobel, but to democratize its spirit—so that the next century of scientific glory belongs not to a few nations, but to all humankind.

Nakul Parashar, PhD
nakul@shantifoundation.global

Letter to the editor

Dear Sir,

Dr. Mary E. Brunkow's Nobel Prize in Physiology or Medicine offers a timely lesson for the research community and the public alike. She was not on the much-discussed "Stanford list" of highly cited scientists; she has only 34 papers to her name and an H-index of 21. There was no citation race, no spotlight chase, no marathon for metrics. Yet she stood on the Nobel stage because her work reshaped how we understand the immune system—changing lives rather than merely improving numbers.

In an era when rankings, dashboards, and indices threaten to become ends in themselves, Dr. Brunkow's career underscores a different ethic: while many chase rankings, she pursued truth; while many count papers, she counted impact; while many sought recognition, she quietly built revolutionary ideas.

Her story sends a powerful message to every woman in science—and to every young researcher regardless of gender: you do not need to be on a list to be at the top of the world. Real recognition should flow from impact, not visibility.

Let us celebrate—and fund—those who stand long hours in the lab, confront bias, ask brave questions, and move science forward one careful idea at a time. If our institutions reward depth over display, we will see more discoveries like Dr. Brunkow's, and society will be the richer for it.

Yours faithfully,
RS Jayasomu
Chennai| E: somu1964@gmail.com

In The News

Hidden switch controlling hunger

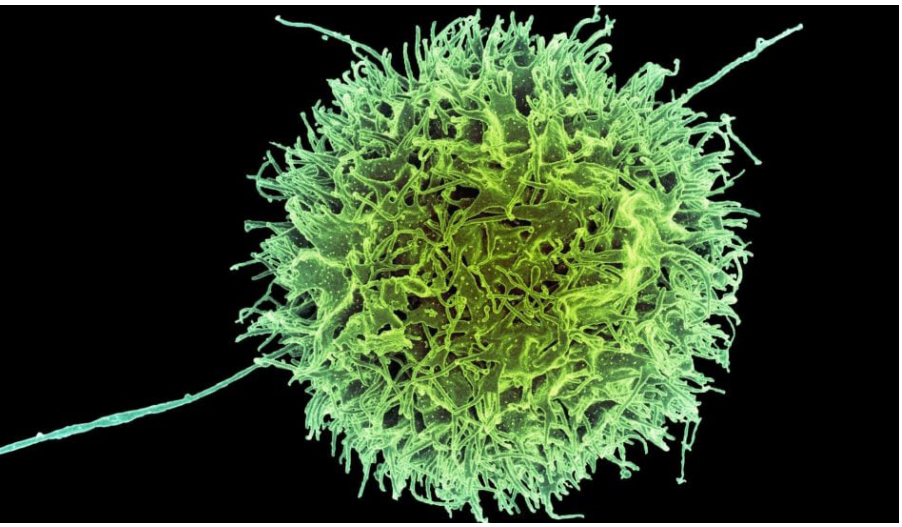
The melanocortin-4 receptor (MC4R) plays a key role in regulating appetite by responding to the pep-tide hormone MSH. It is a major focus of Collaborative Research Centre (CRC) 1423, where researchers study its structure and function. Variations in the MC4R gene are among the most common genetic causes of severe obesity. Earlier structural studies, including those involving the anti-obesity drug set-melanotide, have deepened our understanding of receptor activation. Setmelanotide reduces hunger by activating MC4R. In a new interdisciplinary study involving five CRC 1423 projects, researchers ex-plored how MC4R is transported and made available at the cell surface. Using advanced fluorescence microscopy and single-cell imaging, they discovered that a protein called MRAP2 is essential for guiding MC4R to the cell membrane, where it can send appetite-suppressing signals. This adds a new layer to how hunger is regulated. According to the researchers, this collaboration combined expertise in mi-croscopy, pharmacology, and structural biology. They also add that the findings may help develop therapies targeting MRAP2 to treat obesity. The research highlights the impact of interdisciplinary ef-forts in understanding metabolic regulation.

New catalyst could make plastic recycling easy

Researchers at Northwestern University have developed a groundbreaking method to upcycle mixed plastic waste using a low-cost, nickel-based catalyst. This catalyst selectively breaks down polyolefins—plastics like polyethylene and polypropylene, which account for nearly two-thirds of global single-use plastic—into valuable oils and waxes. Remarkably, the process eliminates the need to pre-sort waste and works even when contaminated with PVC, a material long considered to make recycling unfeasi-ble. The key innovation lies in the catalyst's single-site molecular design, which enables precise target-ing of strong carbon-carbon bonds in polyolefins. Compared to existing methods, it operates at lower temperatures, uses less hydrogen, and requires minimal catalyst loading, while delivering higher activi-ty and stability. Unlike traditional recycling processes that are energy-intensive or result in low-quality materials, this method offers an efficient, scalable, and economical alternative. Even when 25% of the waste contains PVC, the catalyst remains effective—and unexpectedly performs better. The team hopes this discovery could transform plastic recycling, reduce environmental impact, and reclaim plas-tics once deemed unrecyclable due to contamination or mixed composition.

“Invisible” immune cells that obliterate cancer

MIT researchers have developed a method to engineer natural killer (NK) cells that can evade a pa-tient’s immune system while effectively targeting cancer. NK cells can be mass-produced for off-the-shelf cancer therapies, but they are often rejected by the immune system, which sees them as foreign. To address this, the researchers focused on removing HLA class I proteins from the surface of NK cells. These proteins, if unrecognized, can trigger T cells to attack. The team used short interfering RNA (siR-NA) to silence HLA class I genes and added genes for a chimeric antigen receptor (CAR), as well as ei-ther PD-L1 or single-chain HLA-E (SCE), which enhance cancer-killing ability. All these genes were com-bined into one DNA construct, simplifying the transformation of donor NK cells. The engineered CAR-NK cells targeted CD19, a protein found on lymphoma cells. In mouse models with human-like immune systems, these cells persisted for over three weeks and significantly reduced tumor burden, unlike unmodified NK cells, which were quickly destroyed. The modified CAR-NK cells also caused fewer side effects. Researchers now plan clinical trials and are exploring potential use in treating autoimmune diseases like lupus. ◆



Can time itself form a crystal?

Nature follows many rhythms—from Earth’s orbit creating seasons to a pendulum marking time. These predictable patterns often arise from simple, external forces. However, some rhythms emerge spontaneously without outside influence. One such phenomenon is the time crystal, a structure that displays a repeating pattern in time, rather than in space. Researchers at TU Wien (Vienna) have dis-covered a new mechanism behind time crystal formation. Traditionally, quantum correlations be-tween particles were believed to prevent such patterns from forming. Surprisingly, the team showed these very correlations can help stabilize time crystals. Similar to how a liquid freezes into a spatially ordered crystal, a seemingly random quantum system can break temporal symmetry, producing a re-peating pattern in time. Felix Russo, a doctoral researcher under Prof. Thomas Pohl, explains that the team used a two-dimensional lattice of particles held by lasers. These particles began to oscillate due to their quantum interactions—without any external rhythm. This discovery deepens our understand-ing of many-body quantum systems and opens potential pathways for future quantum technologies and precision measurement tools. It also challenges previous assumptions about the role of disorder and quantum fluctuations in complex systems. ◆

Ritavan's Data Impact is an uncommonly clear, intelligent, and necessary intervention in the noise surrounding digital transformation. In an era when every organisation claims to be data-driven yet few can trace measurable value from their dashboards, this book offers a vocabulary of sanity. Written for legacy enterprises rather than digital natives, it is a call to reclaim control from consultants, vendors, and hype merchants, and to restore the conversation to what truly matters—impact.

The author's central argument is disarmingly simple: data projects must serve the balance sheet, not the ego. He replaces the fashionable slogans of artificial intelligence and machine learning with a disciplined business framework built on six verbs—Save, Leverage, Align, Simplify, Optimise, and Grow. Together they form the SLASOG model, a practical guide to turning information into action. The sequence is intuitive yet powerful: first eliminate waste and duplication, then use the strengths already present in a firm's legacy, align people and incentives with a single value narrative, simplify tools and processes, optimise through fast feedback, and finally grow what demonstrably works.

The tone throughout is that of a practitioner who has lived through transformation projects and measured their costs. Ritavan writes with the impatience of experience and the precision of someone who has seen too many "strategic" initiatives collapse under their own weight. His examples come not from glamorous tech startups but from legacy businesses and traditional sectors like industrials, insurance, retail and energy. All these examples involve clarity, discipline, and alignment.

Ritavan's prose is free of jargon and full of consequence. The book's greatest achievement lies in translating the abstract promise of data into the tangible grammar of business. It demonstrates that analytics is not an engineering function but a management practice, and that sustainable digital transformation begins with first principles rather than technology procurement.

If the book has a deliberate limitation, it is its refusal to descend into technical depth. Readers expecting detailed architectures or code-level advice may find the treatment light. Yet this restraint is what makes Data Impact valuable. It focuses not on data literacy but on impact literacy—the art of asking, "What measurable improvement are we pursuing, and how do we maximise it?" For leaders in developing economies, that question is very relevant. It invites them to be rigorous, save ressources, leverage their unique strengths, ensure alignment, simplify and optimize to maximise returns and grow.

What emerges is a philosophy of frugal data-driven value creation, perfectly aligned with contemporary movements such as Digital India and Atmanirbhar Bharat. Ritavan reminds us that excellence does not require extravagance, and that intelligence need not be artificial to be impactful. Data Impact belongs beside Measure What Matters and The Lean Startup as a compass for evidence-based growth. In a world addicted to dashboards and buzzwords, it restores focus to outcomes and impact. This is a rare business book—quiet, rigorous, and germane—that makes data feel not distant and mechanical but human and purposeful. Its message is timeless: the only metric that counts is impact.

Title: Data Impact: How legacy businesses SAVE, LEVERAGE, ALIGN, SIMPLIFY, OPTIMISE, GROW to WIN
Author: Ritavan
Publisher: Rethink Press, UK
Publication date: April 2025
ISBN: 978-1781339213
Pages: 222 pp.

Nobelförsamlingen
The Nobel Assembly at Karolinska Institutet

PRESS RELEASE
6 October 2025

The Nobel Prize in Physiology or Medicine 2025

The Nobel Assembly at Karolinska Institutet has decided to award the Nobel Prize in Physiology or Medicine 2025 to:

Mary E. Brunkow
Institute for Systems Biology,
Seattle, USA

Fred Ramsdell
Sonoma Biotherapeutics,
San Francisco, USA

Shimon Sakaguchi
Osaka University,
Osaka, Japan

"for their discoveries concerning peripheral immune tolerance"

They discovered how the immune system is kept in check

The body's powerful immune system must be regulated, or it may attack our own organs. Mary E. Brunkow, Fred Ramsdell and Shimon Sakaguchi are awarded the Nobel Prize in Physiology or Medicine 2025 for their groundbreaking discoveries concerning peripheral immune tolerance that prevents the immune system from harming the body.

Every day, our immune system protects us from thousands of different microbes trying to invade our bodies. These all have different appearances, and many have developed similarities with human cells as a form of camouflage. So how does the immune system determine what it should a>ack and what it should defend?

Mary Brunkow, Fred Ramsdell and Shimon Sakaguchi are awarded the Nobel Prize in Physiology or Medicine 2025 for their fundamental discoveries relating to peripheral immune tolerance. The laureates identified the immune system's security guards, *regulatory T cells*, which prevent immune cells from a>acking our own body.

"Their discoveries have been decisive for our understanding of how the immune system functions and why we do not all develop serious autoimmune diseases," says Olle Kämpe, chair of the Nobel Committee.

Shimon Sakaguchi was swimming against the tide in 1995, when he made the first key discovery. At the time, many researchers were convinced that immune tolerance only developed due to potentially harmful immune cells being eliminated in the thymus, through a process called *central tolerance*. Sakaguchi showed that the immune system is more complex and discovered a previously unknown class of immune cells, which protect the body from autoimmune diseases.

Mary Brunkow and Fred Ramsdell made the other key discovery in 2001, when they presented the explanation for why a specific mouse strain was particularly vulnerable to autoimmune diseases. They had discovered that the mice have a mutation in a gene that they named *Foxp3*. They also showed that mutations in the human equivalent of this gene cause a serious autoimmune disease, IPEX.

Two years after this, Shimon Sakaguchi was able to link these discoveries. He proved that the *Foxp3* gene governs the development of the cells he identified in 1995. These cells, now known as regulatory T cells, monitor other immune cells and ensure that our immune system tolerates our own tissues.

The laureates' discoveries launched the field of peripheral tolerance, spurring the development of medical treatments for cancer and autoimmune diseases. This may also lead to more successful transplantations. Several of these treatments are now undergoing clinical trials.

Mary E. Brunkow, born 1961. Ph.D. from Princeton University, Princeton, USA. Senior Program Manager at the Institute for Systems Biology, Seattle, USA.

Fred Ramsdell, born 1960. Ph.D. 1987 from the University of California, Los Angeles, USA. Scientific Advisor, Sonoma Biotherapeutics, San Francisco, USA.

Shimon Sakaguchi, born 1951. M.D. 1976 and Ph.D. 1983 from Kyoto University, Japan. Distinguished Professor at the Immunology Frontier Research Center, Osaka University, Japan.

Prize amount: 11 million Swedish kronor, to be shared equally between the laureates.
Press contact: Pernilla Witte, +46 8 524 86 107, pernilla.witte@nobelprizemedicine.org or Thomas Perlmann, thomas.perlmann@nobelprizemedicine.org, Secretary-General, The Nobel Assembly at Karolinska Institutet.

What is Peripheral Immune Tolerance?

Imagine your immune system as a city's security force. Its mission is to spot and stop threats—viruses, bacteria, cancer cells—without hassling peaceful citizens like your own tissues, the food you eat, or the friendly bacteria living in your gut. Peripheral immune tolerance is the set of "common-sense rules" that guides this security team out on the streets, after officers have graduated from the academy. Without these rules, the team would overreact, arrest the wrong people, and the city would constantly be in chaos. With them, life runs smoothly.

One rule is called anergy, which you can think of as a "do-not-chase" list. If a security officer meets someone who looks a little unusual but there's no real sign of danger—no yelling, no broken windows, no alarm going off—the officer learns not to chase that person next time. Immune cells do the same thing: when they encounter a harmless molecule, especially one from your own body, without the chemical "alarm bells" that signal an infection, they become unresponsive to it. The cell isn't dead; it just won't make a fuss about that thing again. This stops a lot of false alarms before they start.

A second rule involves peacekeepers, known in biology as regulatory T cells (Tregs). These are the calm mediators who show up when a scuffle starts and tell everyone to take a breath. Tregs release soothing signals that make other immune cells less jumpy and also coach local "neighborhood watch" cells to present information more calmly. In everyday life, this matters after you eat: Tregs help your body stay chill about food proteins like peanut or wheat—substances that are foreign but not dangerous—so you don't get unnecessary inflammation every time you have a snack.

The third rule is deletion, which is like dismissing a hot-headed officer who keeps escalating small issues into big ones. When an immune cell repeatedly targets something it shouldn't—say, proteins in your joints—it can be instructed to self-destruct. That might sound drastic, but it protects the city from chronic trouble like autoimmune arthritis. Removing the few troublemakers keeps the whole force trustworthy.

Some parts of the city are designated quiet zones: the eyes, brain, and testes are examples of "immune-privileged" areas. Here, the rules are extra strict: fewer patrols, more caution, special signals that discourage aggressive responses. It's like posting signs that say "Silence, please—research in progress." Inflammation in these places can cause lasting damage, so the system errs on the side of calm. If a minor disturbance happens, the local rules help resolve it without turning it into a riot.

Finally, every officer has built-in brakes—checkpoint molecules like PD-1 and CTLA-4. During a long or intense pursuit, these brakes make sure the chase doesn't become reckless. They're essential for preventing friendly fire: too much enthusiasm can damage the city itself. Doctors even use medicines that release these brakes to help the immune system attack cancers more strongly, which shows how powerful the braking system normally is.

Why does all this matter? First, peripheral tolerance prevents autoimmunity—your immune system mistaking you for an invader. Without it, everyday activities would be risky: sun exposure might trigger skin attacks, a sore throat could spiral into heart inflammation, or a sandwich could start a battle in your gut. Second, tolerance lets you live peacefully with beneficial microbes and routine foods, saving energy for real threats. Third, it keeps responses proportional: enough to clear infections, not so much that the cleanup crew wrecks the neighborhood.

Of course, balance is everything. If tolerance is too weak, you get autoimmune diseases—guards arresting citizens. If it's too strong, tumors or chronic infections may slip by—guards waving through real criminals. Health depends on keeping these dials tuned just right.

Mary E. Brunkow

Fred Ramsdell

Shimon Sakaguchi

The Nobel Prize in Physics 2025

PRESS RELEASE

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics 2025 to

John Clarke
University of California, Berkeley, USA

Michel H. Devoret
Yale University, New Haven, CT and
University of California, Santa Barbara, USA

John M. Martinis
University of California, Santa Barbara, USA

"for the discovery of macroscopic quantum mechanical tunnelling and energy quantisation in an electric circuit"

Their experiments on a chip revealed quantum physics in action

A major question in physics is the maximum size of a system that can demonstrate quantum mechanical effects. This year's Nobel Prize Laureates conducted experiments with an electrical circuit in which they demonstrated both quantum mechanical tunnelling and quantised energy levels in a system big enough to be held in the hand.

Quantum mechanics allows a particle to move straight through a barrier, using a process called tunnelling. As soon as large numbers of particles are involved, quantum mechanical effects usually become insignificant. The laureates' experiments demonstrated that quantum mechanical properties can be made concrete on a macroscopic scale.

In 1984 and 1985, **John Clarke, Michel H. Devoret and John M. Martinis** conducted a series of experiments with an electronic circuit built of superconductors, components that can conduct a current with no electrical resistance. In the circuit, the superconducting components were separated by a thin layer of non-conductive material, a setup known as a Josephson junction. By refining and measuring all the various properties of their circuit, they were able to control and explore the phenomena that arose when they passed a current through it. Together, the charged particles moving through the superconductor comprised a system that behaved as if they were a single particle that filled the entire circuit. This macroscopic particle-like system is initially in a state in which current flows without any voltage.

The system is trapped in this state, as if behind a barrier that it cannot cross. In the experiment the system shows its quantum character by managing to escape the zero- voltage state through tunnelling. The system's changed state is detected through the appearance of a voltage.The laureates could also demonstrate that the system behaves in the manner predicted by quantum mechanics - it is quantised, meaning that it only absorbs or emits specific amounts of energy.

"It is wonderful to be able to celebrate the way that century-old quantum mechanics continually offers new surprises. It is also enormously useful, as quantum mechanics is the foundation of all digital technology," says Olle Eriksson, Chair of the Nobel Committee for Physics. The transistors in computer microchips are one example of the established quantum technology that surrounds us. This year's Nobel Prize in Physics has provided opportunities for developing the next generation of quantum technology, including quantum cryptography, quantum computers, and quantum sensors.

John Clarke, born 1942 in Cambridge, UK. PhD 1968 from the University of Cambridge, UK. Professor at University of California, Berkeley, USA.

Michel H. Devoret, born 1953 in Paris, France. PhD 1982 from the Paris-Sud University, France. Professor at Yale University, New Haven, CT and University of California, Santa Barbara, USA.

John M. Martinis, born 1958. PhD 1987 from the University of California, Berkeley, USA. Professor at the University of California, Santa Barbara, USA.

Prize amount: 11 million Swedish kronor, to be shared equally between the laureates. Further information: www.kva.se and www.nobelprize.org Press contact: Eva Nevelius, Press Secretary, +46 70 878 67 63, eva.nevelius@kva.se Experts: Göran Johansson, +46 31 772 32 37, goran.l.johansson@chalmers.se and Eva Lindroth, +46 8 553 786 16, lindroth@fysik.su.se, members of the Nobel Committee for Physics.

The Royal Swedish Academy of Sciences, founded in 1739, is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society. The Academy takes special responsibility for the natural sciences and mathematics, but endeavours to promote the exchange of ideas between various disciplines.

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

Quantum Tunneling, Made Simple

For a long time, people thought the strange rules of quantum physics only applied to tiny things like atoms and electrons. In the 1980s, three scientists–John Clarke, Michel Devoret, and John Martinis–showed that this isn't true. They built special, super-cold electrical circuits where billions of electrons moved together like one object and followed quantum rules. In 2025, they received the Nobel Prize in Physics for this work. Their message was clear: quantum effects can be built, controlled, and used at a scale we can engineer.

The key idea is quantum tunneling. Imagine throwing a ball at a wall. In normal life, the ball bounces back. In the quantum world, there is a tiny chance it appears on the other side without breaking the wall. The scientists created a device called a Josephson junction–two superconductors with a very thin insulator in between. In this device, paired electrons can sometimes "tunnel" through the thin barrier even when they don't have enough energy to go over it. They also found that the circuit's energy comes in fixed steps, not a smooth range–like a staircase, not a ramp. Because of this, the circuit behaves like an "artificial atom": it only absorbs certain microwave frequencies and ignores the rest.

This may sound like lab magic, but it leads to real tools we use every day. Your phone's flash memory depends on tunneling. Data is stored by trapping or releasing electrons in tiny "floating gates." The insulating wall around each gate is so thin that, with the right voltage, electrons can tunnel in or out. Trillions of these small events let your photos and messages stay saved even when the power is off.

Hospitals use quantum effects too. SQUIDs (Superconducting QUantum Interference Devices) are the most sensitive magnetic sensors we have. They are made from superconducting loops with a Josephson junction. Tiny changes in magnetic fields–like those from brain activity–slightly change how electrons tunnel in the device. Doctors use this in magnetoencephalography (MEG) to map brain signals and plan treatments, especially for epilepsy. Quantum rules also lie behind MRI machines, whose strong superconducting magnets and precise signals come from a deep understanding of how atoms behave.

Accurate timing is another gift of quantum physics. Atomic clocks keep time by using fixed energy jumps inside atoms–the same idea as the "energy steps" in the artificial atom. These clocks are so steady that they keep GPS working. If the timing drifted even a tiny bit, your map would show you far from your real location. The stability and precision we rely on for navigation, internet time, and communications come from quantum behavior.

Looking ahead, quantum computers use circuits very similar to those in the Nobel-winning work. Their basic units, qubits, can be in a mix of 0 and 1 at the same time. Many of the best qubits today are built from superconducting circuits with Josephson junctions. Engineers control their energy steps and tunneling to set and read quantum states. These machines won't replace your laptop, but they can attack special problems–like designing new drugs and materials or improving complex schedules–that overwhelm normal computers.

If tunneling is real, why can't you walk through a wall? Because everyday barriers are thick and messy, and your body has an unimaginable number of particles. Getting them all to tunnel together is practically impossible. In the lab, scientists also cool their circuits to near absolute zero so thermal noise doesn't drown out quantum effects. Nature allows tunneling, but the conditions have to be just right.

In short, Clarke, Devoret, and Martinis showed that quantum rules can guide big, human-made systems, not just tiny particles. That changed quantum physics from a curiosity into a toolbox. It's why your phone stores so much data so reliably. It's how doctors read faint magnetic signals from the brain. It keeps GPS accurate. And it's powering new kinds of computers. Quantum physics may sound strange, but thanks to careful experiments, it now shapes everyday technology in simple, practical ways.

John Clarke

Michel H. Devoret

John M. Martinis

The Nobel Prize in Chemistry 2025 PRESS RELEASE

TheRoyalSwedishAcademyofScienceshasdecidedtoawardtheNobelPrizeinChemistry 2025 to

Susumu Kitagawa
KyotoUniversity,Japan

Richard Robson
University of Melbourne, Australia

Omar M. Yaghi
UniversityofCalifornaJBerkeley, USA

"for the development of metal–organic frameworks"

Their molecular architecture contains rooms for chemistry

The Nobel Prize Laureates in Chemistry 2025 have created molecular constructions with large spaces through which gases and other chemicals can flow. These constructions, ***metal-organic frameworks***, can be used to harvest water from desert air, capture carbon dioxide, store toxic gases or catalyse chemical reactions. **Susumu Kitagawa**, **Richard Robson** and **Omar Yaghi** are awarded the Nobel Prize in Chemistry 2025. They have developed a new form of molecular architecture. In their constructions, metal ions function as cornerstones that are linked by long organic (carbon-based) molecules. Together, the metal ions and molecules are organised to form crystals that contain large cavities. These porous materials are called metal-organic fram- eworks (MOF). By varying the building blocks used in the MOFs, chemists can design them to capture and store specific substances. MOFs can also drive chemi- cal reactions or conduct electricity.

"Metal-organic frameworks have enormous potential, bringing previously unforeseen opportunities for custom-made materials with new functions," says Heiner Linke, Chair of the Nobel Committee for Chemistry.

It all started in 1989, when Richard Robson tested utilising the inherent properties of atoms in a new way. He combined positively charged copper ions with a four-armed molecule; this had a chemical group that was attracted to copper ions at the end of each arm.

When they were combined, they bonded to form a well-ordered, spacious crystal. It was like a diamond filled with innumerable cavities. Robson immediately recognised the potential of his molecular construction, but it was unstable and collapsed easily. However, Susumu Kitagawa and Omar Yaghi provided this building method with a firm foundation; between 1992 and 2003 they made, separately, a series of revolutionary discoveries. Kitagawa showed that gases can flow in and out of the constructions and predicted that MOFs could be made flexible. Yaghi created a very stable MOF and showed that it can be modified using rational design, giving it new and desirable properties.
Following the laureates' groundbreaking discoveries, chemists have built tens of thousands of different MOFs. Some of these may contribute to solving some of humankind's greatest challenges, with applications that include separating PFAS from water, breaking down traces of pharmaceuticals in the environment, capturing carbon dioxide or harvesting water from desert air.

Susumu Kitagawa, born 1951 in Kyoto, Japan. PhD 1979 from the Kyoto University, Japan. Professor at Kyoto University, Japan.

Richard Robson, born 1937 in Glusburn, UK. PhD 1962 from University of Oxford, UK. Professor at University of Melbourne, Australia.

Omar M. Yaghi, Born 1965 in Amman, Jordan. PhD 1990 from University of Illinois Urbana-Champaign, USA. Professor at University of California, Berkeley, USA.

Prize amount: 11 million Swedish kronor to be shared equally between the laureates Further information: www.kva.se and www.nobelprize.org Press contact: Eva Nevelius, Press Secretary, +46 70 878 67 63, eva.nevelius@kva.se Expert: Olof Ramström, +46 70 433 42 60, ramstrom@protonmail.com, member of the Nobel Committee for Chemistry

The Royal Swedish Academy of Sciences, founded in 1739, is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society. The Academy takes special responsibility for the natural sciences and mathematics, but endeavours to promote the exchange of ideas between various disciplines.

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

What are Metal–organic frameworks (MOFs)?

These are crystalline, porous materials made from metal ions or clusters joined by organic molecules called linkers. Imagine a precise 3D scaffold where metal "nodes" and organic "struts" assemble into a lattice with enormous internal surface area—often thousands of square meters per gram—and up to ~90% empty space. Because chemists can choose the metal, the linker length, and functional groups, they can tune pore size, shape, and chemistry almost like molecular LEGO, yielding predictable, tailor-made crystals rather than random foams.

MOFs typically form by self-assembly: solutions of metal salts and linkers are heated or solvothermally treated so the parts snap into place. Small changes in temperature, solvent, pH, or additives steer outcomes—larger or smaller pores, greater stability, or specific chemical groups lining channels. Post-synthetic modification can further decorate the pores, and the vast menu of metals and linkers means a near-limitless design space.

These features make MOFs powerful wherever interactions with small molecules matter. In environmental uses, their adjustable pores and surface chemistry allow high-density gas storage and sharp separations. MOFs can pack hydrogen for cleaner fuels and selectively capture carbon dioxide from mixed gas streams, aiding industrial emissions control and direct-air capture. Water-stable MOFs shaped into membranes or powders filter heavy metals, organic dyes, pesticides, and even radioactive iodine, improving water quality. Many frameworks act as catalysts because reactants flow through channels to meet active metal sites across a gigantic surface. Others are engineered to change their glow in the presence of target molecules, enabling sensitive chemical sensors for explosives, pollutants, or humidity.

Energy technologies also benefit. In batteries and supercapacitors, MOFs' open networks provide short pathways for ions like Li^+ and abundant sites to host charge, potentially boosting capacity and charging speed. Although pristine MOFs are usually not very conductive, they can be converted into porous carbons or metal oxides that preserve the original architecture while adding electron pathways. As electrocatalysts and catalyst precursors, MOF-based materials help drive oxygen reduction and evolution reactions in fuel cells and metal–air batteries. Some MOFs absorb light like semiconductors and, with the right design, photocatalyze water splitting to produce hydrogen or reduce CO_2 into useful chemicals.

Biomedical research leverages the same tunability. Nano-MOFs can load high amounts of therapeutic cargo in their pores and release it steadily or in response to triggers such as pH or enzymes, potentially lowering doses and side effects. Biocompatible frameworks can carry imaging agents for MRI or act as biosensors. Enzymes immobilized inside a MOF are shielded from harsh conditions yet remain active, extending their usefulness in diagnostics and green chemistry.

Challenges remain. Early MOFs sometimes degraded in heat or humidity, but newer families—especially those with strong metal–oxygen bonds such as zirconium-based frameworks—exhibit excellent thermal and water stability. Limited conductivity is addressed with conductive MOFs and MOF-derived carbons/oxides. Scaling from grams to tons requires greener solvents, simpler linkers, and continuous production—areas now seeing rapid progress. For medical uses, rigorous evaluation of safety, biodegradation, and clearance is essential.

The appeal of MOFs is their combination of huge surface area and atom-level precision. You can design a pore to welcome one molecule, reject another, speed a reaction, or carry a drug—and then build that design as a solid crystal. As stability improves and manufacturing scales, expect MOFs in carbon-capture modules, hydrogen storage, smart separation membranes, high-performance electrodes and catalysts, targeted delivery systems, and ultrasensitive sensors. They are designer sponges for the atomic world, enabling us to store, sort, sense, and transform molecules with unprecedented control.

Susumu Kitagawa

Richard Robson

Omar M Yaghi

13 October 2025

The Prize in Economic Sciences 2025

The Royal Swedish Academy of Sciences has decided to award the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2025 to Joel Mokyr, Philippe Aghion and Peter Howitt

"for having explained innovation-driven economic growth"

with one half to

Joel Mokyr

Northwestern University, Evanston, IL, USA

"for having identified the prerequisites for sustained growth through technological progress"

and the other half jointly to

Philippe Aghion

Collège de France and INSEAD, Paris, France, The London School of Economics and Political Science, UK

Peter Howitt

Brown University, Providence, RI, USA

"for the theory of sustained growth through creative destruction"

They show how new technology can drive sustained growth

Over the last two centuries, for the first time in history, the world has seen sustained economic growth. This has lifted vast numbers of people out of poverty and laid the foundation of our prosperity. This year's laureates in the Economic Sciences, Joel Mokyr, Philippe Aghion and Peter Howitt, explain how innovation provides the impetus for further progress.

Technology advances rapidly and affects us all, with new products and production methods replacing old ones in a never-ending cycle. This is the basis for sustained economic growth, which results in a better standard of living, health and quality of life for people around the globe.

However, this was not always the case. Quite the opposite – stagnation was the norm throughout most of human history. Despite important discoveries now and again, which sometimes led to improved living conditions and higher incomes, growth always eventually levelled off.

Joel Mokyr used historical sources as one means to uncover the causes of sustained growth becoming the new normal. He demonstrated that if innovations are to succeed one another in a self-generating process, we not only need to know *that* something works, but we also need to have scientific explanations for *why*. The latter was often lacking prior to the industrial revolution, which made it difficult to build upon new discoveries and inventions. He also emphasised the importance of society being open to new ideas and allowing change.

Philippe Aghion and **Peter Howitt** also studied the mechanisms behind sustained growth. In an article from 1992, they constructed a mathematical model for what is called *creative destruction*: when a new and better product enters the market, the companies selling the older products lose out. The innovation represents something new and is thus creative. However, it is also destructive, as the company whose technology becomes passé is outcompeted.

In different ways, the laureates show how creative destruction creates conflicts that must be managed in a constructive manner. Otherwise, innovation will be blocked by established companies and interest groups that risk being put at a disadvantage.

"The laureates' work shows that economic growth cannot be taken for granted. We must uphold the mechanisms that underly creative destruction, so that we do not fall back into stagnation," says John Hassler, Chair of the Committee for the Prize in Economic Sciences.

Joel Mokyr, born 1946 in Leiden, the Netherlands. PhD 1974 from Yale University, New Haven, CT, USA. Professor at Northwestern University, Evanston, IL, USA.

Philippe Aghion, born 1956 in Paris, France. PhD 1987 from Harvard University, Cambridge, MA, USA. Professor at Collège de France and INSEAD, Paris, France and The London School of Economics and Political Science, UK.

Peter Howitt, born 1946 in Canada. PhD 1973 from Northwestern University, Evanston, IL, USA. Professor at Brown University, Providence RI, USA.

Prize amount: 11 million Swedish kronor, with one half to Joel Mokyr and the other half jointly to Philippe Aghion and Peter Howitt.
Further information: www.kva.se och www.nobelprize.org
Press contact: Eva Nevelius, Press Secretary, +46 70 878 67 63, eva.nevelius@kva.se
Experts: Kerstin Enflo, +46 70 374 83 91, kerstin.enflo@ekh.lu.se and John Hassler, +46 70 811 72 63, john.hassler@iies.su.se, members of the Committee for the Prize in Economic Sciences in Memory of Alfred Nobel.

The Royal Swedish Academy of Sciences, founded in 1739, is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society. The Academy takes special responsibility for the natural sciences and mathematics, but endeavours to promote the exchange of ideas between various disciplines.

What is innovation-driven economic growth?

The 2025 Nobel laureates in Economic Sciences — Joel Mokyr, Philippe Aghion, and Peter Howitt — converge on a powerful idea: prosperity is not inherited, it is invented. Nations grow rich not by chance or natural resources but by building systems that continuously discover, test, and spread new ideas. Innovation, in their view, is the true capital of civilisation.

Economic historian Joel Mokyr reframes growth as an intellectual rather than purely material process. The ultimate fuel, he argues, is useful knowledge — both propositional knowledge (theories, models, principles) and prescriptive knowledge (methods, designs, and processes). When these two forms expand together, discovery compounds, mistakes refine understanding, and productivity surges. Mokyr's historical research demonstrates that societies that encourage curiosity, open inquiry, and merit-based education — such as the scientific communities of Enlightenment Europe — have turned learning into a pathway to prosperity. In contrast, where censorship, monopoly guilds, or rent-seeking elites prevailed, innovation withered and economies stagnated. In short, freedom of thought and institutional trust matter as much as physical capital. Progress, Mokyr reminds us, is sustained not by resources but by rules that let people think freely.

Economists Philippe Aghion and Peter Howitt provide the dynamic model behind Mokyr's historical insight. Their theory of creative destruction describes how growth emerges from a continuous cycle of innovation and replacement. New technologies disrupt old ones; startups challenge incumbents; productivity rises as a result of this churn. It is an inherently turbulent process, yet without disruption, there can be no renewal. Competition keeps this innovation engine alive — forcing firms to improve or exit, ensuring that talent and capital migrate toward better ideas.

When competition is dulled — through monopoly control, barriers to entry, or weak antitrust enforcement — innovation loses its urgency. Economies then drift toward comfort and decline. Hence, creative destruction is not chaos; it is a disciplined turbulence that sustains progress.

Drawing from the laureates' collective wisdom, innovation-driven growth demands deliberate institutional design. It is not spontaneous; it must be nurtured. Five policy priorities define this approach:

1. Invest in the idea pipeline. Governments should fund both basic and mission-oriented R&D, strengthen STEM education, and promote open science for faster knowledge diffusion. Balanced intellectual property rules should encourage commercialisation without stifling sharing.

2. Keep markets contestable. Dynamic capitalism thrives on fluid competition. Policies should ensure data portability, open technical standards, and capital access for startups — not just incumbents — to maintain a steady flow of new entrants and ideas.

3. Regulate for learning. Regulatory systems should evolve alongside technology. Sandboxes for experimentation, outcome-based rules, and innovation-oriented public procurement can accelerate safe adoption of emerging technologies.

4. Build adaptive institutions. University–industry partnerships, regional innovation clusters, and technology-transfer offices should measure real-world impact, not only patent counts. Immigration policies that attract scientific talent amplify creative potential.

5. Pair innovation with inclusion. Rapid innovation can unsettle workers and regions. Policies should protect people, not jobs — through portable benefits, reskilling programs, and wage insurance. Inclusive growth maintains public consent for technological change.

Innovation, the laureates emphasise, is more than a market process — it is a social and ethical contract. Societies that nurture curiosity, openness, and meritocracy foster enduring growth through invention. Those who fear novelty or centralised control trap themselves in stagnation.

Joel Mokyr

Philippe Aghion

Peter Howitt

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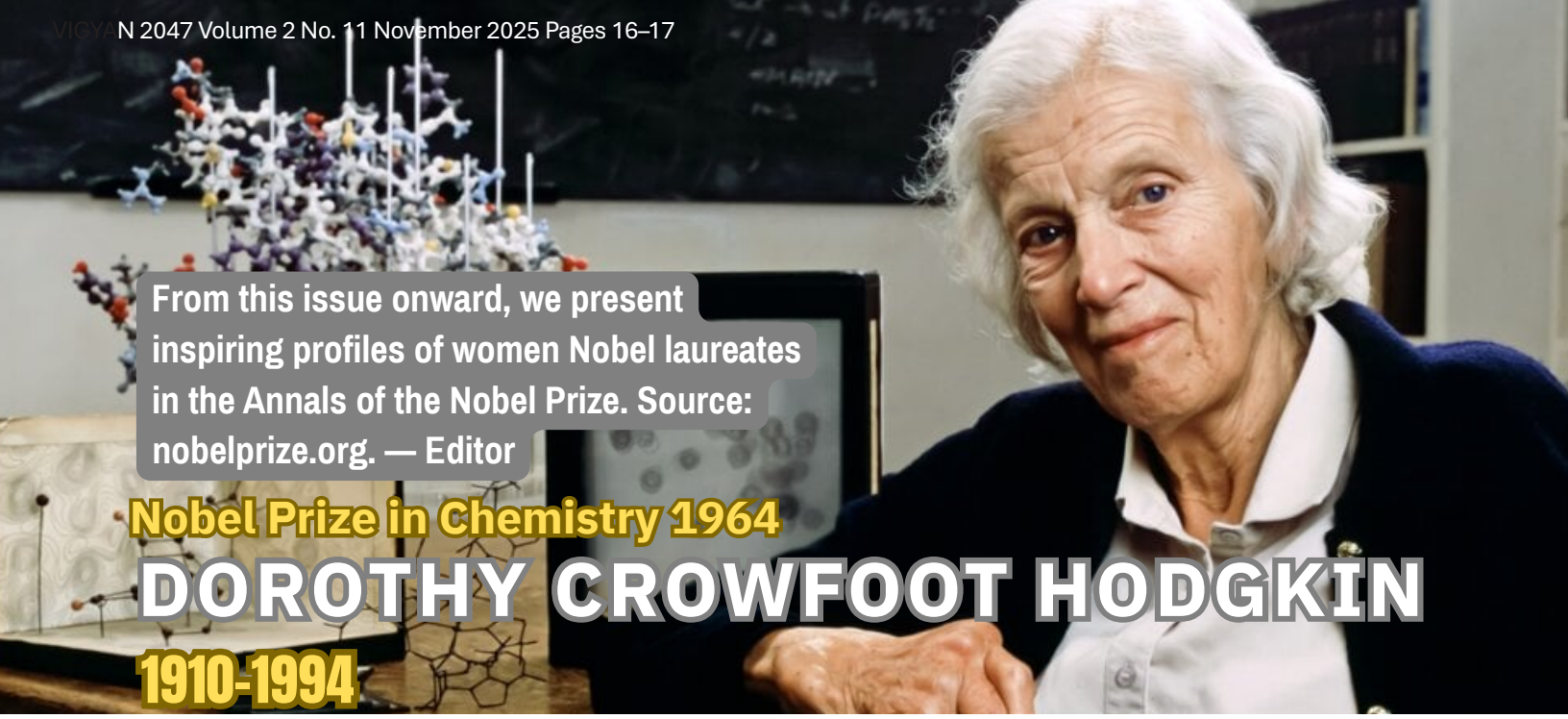

From this issue onward, we present inspiring profiles of women Nobel laureates in the Annals of the Nobel Prize. Source: nobelprize.org. — Editor

Nobel Prize in Chemistry 1964

DOROTHY CROWFOOT HODGKIN

1910-1994

“Captured for life by chemistry and by crystals,” as she described it, Dorothy Hodgkin turned a childhood interest in crystals into the ground-breaking use of X-ray crystallography to “see” the molecules of penicillin, vitamin B12 and insulin. Her work not only allowed researchers to better understand and manufacture life-saving substances, it also made crystallography an indispensable scientific tool.

Born Dorothy Mary Crowfoot in 1910, Hodgkin was raised in England and colonial North Africa. As a child, she was fascinated with crystals; she loved the elegance of their geometric shapes. At age 14, she found a shiny black mineral in the yard while visiting her parents in North Africa, and she asked a family friend, soil scientist A. F. Joseph, if she could analyse it. Joseph gave her a surveyor’s box of reagents and minerals to encourage her.

At age 16, she received another present, one that would set her on her life’s path: a book by William Henry Bragg about using X-rays to analyse crystals. At the Sir John Leman School in Beccles, England, Dorothy Crowfoot Hodgkin and her friend Norah Pusey, in the back row, were the only two girls in the chemistry class. They had to petition to take chemistry rather than “domestic science” with the other girls. Photo: Courtesy of Sir John Leman School

X-ray crystallography allowed scientists to see the structure of molecules that had until then been visualised only in theory. The process involves beaming X-rays through a crystal onto a photographic plate, which records the scatter pattern caused by the interference of electrons surrounding the atoms. That process is repeated with a variety of selected orientations. Then a series of mathematical calculations is used to relate the spots on the plates to the relative arrangement of the atoms. When she was 18, Hodgkin enrolled at Oxford University to study chemistry and pursue her interest in crystallography. For her doctoral work, she joined the lab of J. D. Bernal, a Cambridge University chemist who believed in equal opportunity for women. He helped make crystallography one of the few physical sciences hiring significant numbers of women at that time. In 1934, Bernal photographed the first X-ray of a protein crystal, an achievement that proved organic molecules (and not just inorganic ones) could be crystallised Hodgkin wasn’t in the laboratory on the day of this breakthrough; she was at the doctor because of pain in her hands. Although she was diagnosed with chronic rheumatoid arthritis, she quickly returned to work. She never let the disease stop her, though her hands and feet grew increasingly swollen, twisted and painful.

Crystal structure model, made for the x-ray crystallographer Dorothy Crowfoot Hodgkin, showing the structure of the hexacarboxylic acid fragment of vitamin B12, 1957-1959.

Inspired by the first X-ray of a protein crystal, Hodgkin soon began to investigate the three-dimensional structure of insulin. At this point, she was 24 and teaching chemistry back at Oxford University, with her own (albeit poorly equipped) lab. She paused in her study of insulin to take on penicillin, a more urgent task in the World War II era; it took her four years to map the structure of its 17 atoms. Vitamin B12, which she tackled next, contains 181 atoms and took eight years to map. Eventually, she conquered insulin; with 788 atoms, it took 34 years. The almost insurmountable size of these tasks and the sheer volume of calculations they required turned Hodgkin into an early adopter of evolving technology.

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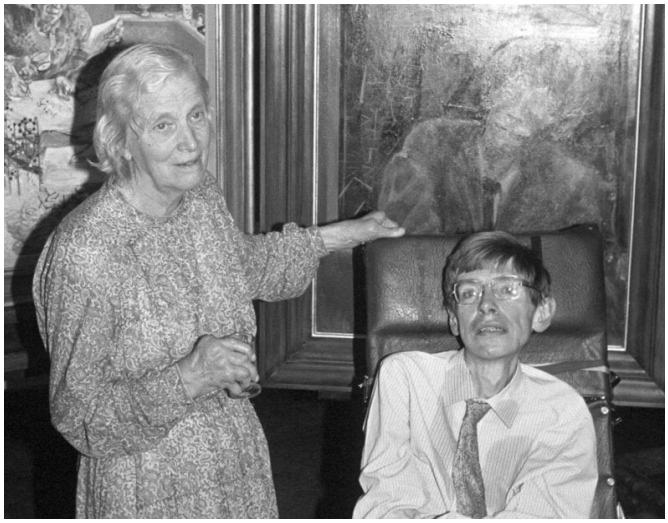
Hodgkin believed in international scientific cooperation. During the Cold War, she insisted on including Chinese and Soviet scientists in organisations such as the International Union of Crystallography, which she helped found. She was also a lifelong advocate for world peace, her conviction formed in part by her mother's loss of all four brothers in World War I. She campaigned against both the Vietnam War and nuclear weapons.

Prime Minister Margaret Thatcher greets her former tutor, 78-year-old Professor Dorothy Crowfoot Hodgkin, before a luncheon for Nobel Laureates at Downing Street, London, 14 April 1989.

"How to abolish arms and achieve a peaceful world is necessarily our first objective," she wrote in 1981. At that time, at age 71, she was president of the Pugwash Conferences on Science and World Affairs, established to address the proliferation of weapons of mass destruction. Hodgkin's life work had immediate implications for medical research. Mapping the structure of penicillin in 1945 made the miracle drug far easier to manufacture. Vitamin B12, which Hodgkin mapped in 1954, is an essential weapon against pernicious anaemia. Her detailed map of insulin in 1969 allowed for vast improvements in the treatment of diabetes. But her achievements resonated beyond their practical applications, expanding limits of X-ray crystallography and thus of scientific knowledge.

Dorothy Crowfoot Hodgkin in her late teens (in the 1920s).

Dorothy Crowfoot Hodgkin (second from left) with Ivan Zupec and Linus and Ava Helen Pauling, 1977.



Dorothy Crowfoot Hodgkin with Stephen Hawking, 17 July 1985, at the National Portrait Gallery in London.

Prime Minister Margaret Thatcher greets her former tutor, 78-year-old Professor Dorothy Crowfoot Hodgkin, before a luncheon for Nobel Laureates at Downing Street, London, 14 April 1989.

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Tribology of Transmission: Gear box

Kamal Mukherjee

The relationship between torque and speed is inversely proportional to each other—if one goes up, the other goes down. So, as the size & weight of an object/machine increases it needs more torque to move it. The torque developed by the prime mover is transmitted to the output components—a) to 'the road wheels' in case of tyre mounted machine (Car, Jeep, SUV, Truck, Trailer, high-capacity Dumper, Payloader, Tractor, JCB, Crane etc.), b) to 'the track chain' in case of crawler (track chain) mounted machine (Excavator, Dozer, Drill etc.) where it needs a larger "propulsive force", or "tractive effort.", c) the torque is also transmitted to operate the hydraulic systems for actuating the hydraulic cylinders, hydraulic pump, hydraulic motor etc., d) to the stationary units e.g. small to a high capacity winches or haulage for pulling an object through a wire rope, e) for simply to increase the torque which are popularly known as speed reducers used in heavy machines. This necessitates the introduction of a considerable "**leverage**" between the prime mover (engine/motor) and the output components as mentioned above & is achieved by a set of gears which multiplies the turning force. Such a converting device with a gear set arrangement is known as "**gear box**" or "**transmission**" (Fig-1) and used in automobiles, turbines, and reduction units in heavy machinery of industrial application. ***Thus, "gear box/transmission does not develop power & it is only a torque multiplying device at the cost of speed."***

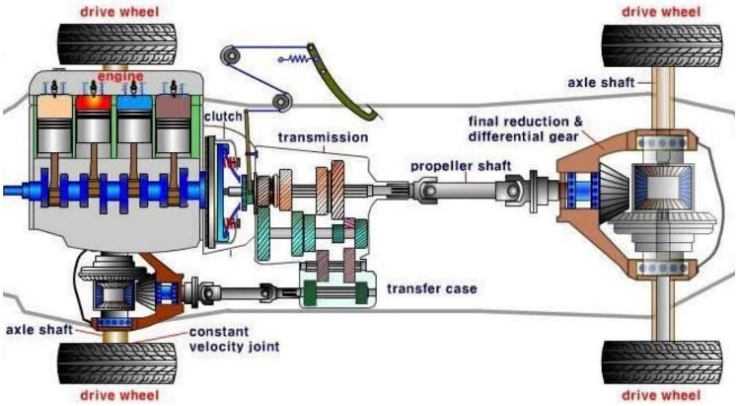


Fig-1: Schematic layout of engine, clutch, transmission, differential & final drive in a typical vehicle

Types of Transmission Systems

The transmission systems can either be a mechanical or electrical or hydraulic (fluid devices in between).

(A) Manual gearbox: Most of the mainstream cars, jeeps, SUV's, tractor & trucks, come with a manual transmission of some kind. Here one has to select the gears manually to speed up & slow down as well as to operate clutch pedal. Manual transmissions (Fig-2) are affordable and easy to maintain compared to automatic transmissions.

(B) Automated Manual Transmission (AMT) / Intelligent Manual Transmission (IMT): AMTs

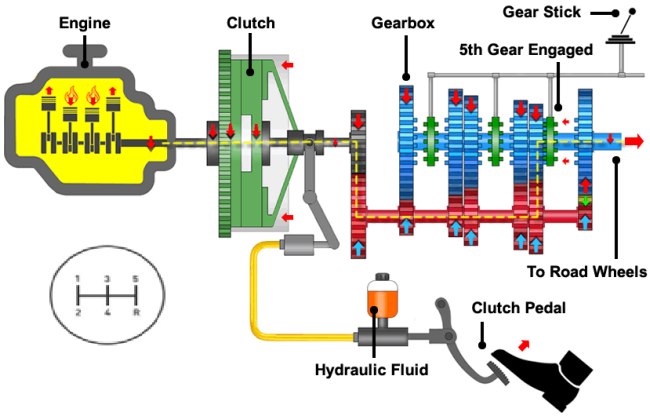


Fig-2: Manual Transmission with 'H' shape gear shifting slots.

use electronic sensors to control gear changes, eliminating the need for a clutch pedal. They are more affordable and fuel-efficient than traditional automatics, but their gear shifts can be slower and less smooth, which may result in a jerky driving experience.

(C) Automatic Transmission: There are many types of automatic transmission as shown below:

(C.1) Continuously Variable Transmission (CVT): This system includes cones at each pulley linked through a belt and moves to increase or decrease the chain belt diameter to change gear ratios. The CVT is reliable and offers higher fuel efficiency.

(C.2) Dual Clutch Transmission (DCT): It employs two clutches to shift gears, one for even gears and another for odd gears, reducing gear shift lag. DCTs have gained popularity in high-performance cars for their quick and smooth shifting making them ideal for sports cars. (Fig-3).

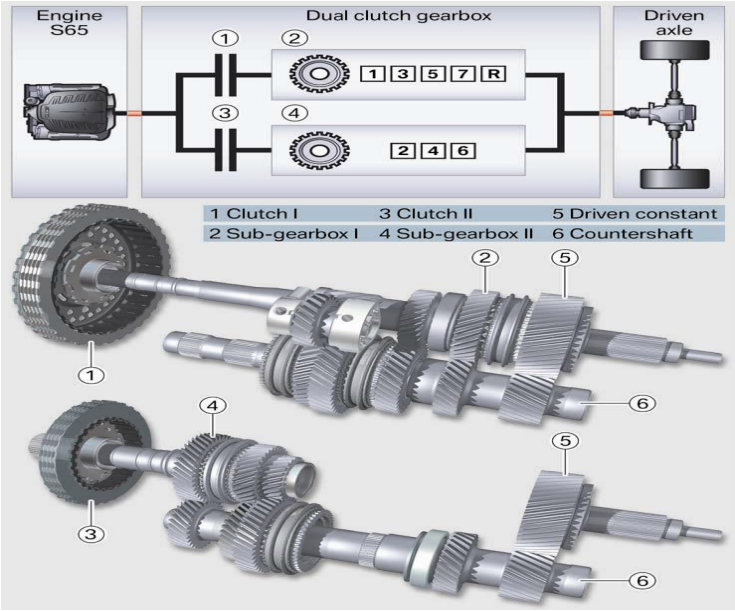


Fig-3: BMW-7 speed double clutch transmission (DCT)

(C.3) Electronically Controlled Automatic Transmission or Hydrodynamic Transmission (HDT): This type of transmission in the car is seen nowadays otherwise they are used in heavy vehicles. One has to select the gear lever position e.g. "P-R-N-D", it's as per the Society of Automotive Engineers (SAE) recommendation: (P) Park, (R) Reverse, (N) Neutral & (D) Drive. As the foot pedal is used to accelerate or decelerate, it automatically selects the speed range. It uses the high velocity of oil flow (kinetic energy) to the torque converter, lockup clutch and planetary gearing. Torque converter provides a continuous variation of speed ratio from lowest to the highest. With electronic control system (ECM), precise & smooth gear shifts with perfectly timed gear shifts are obtained. Additional advantage of electronic control system is that the microcomputer can store diagnostic trouble codes. This greatly assists the mechanics in the quick repair of faulty transmission units (Fig-4 & 5).

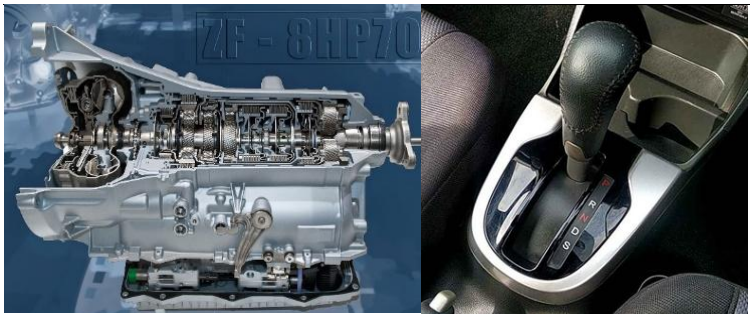


Fig-4: Automatic transmission with PRNDL gear shifting lever

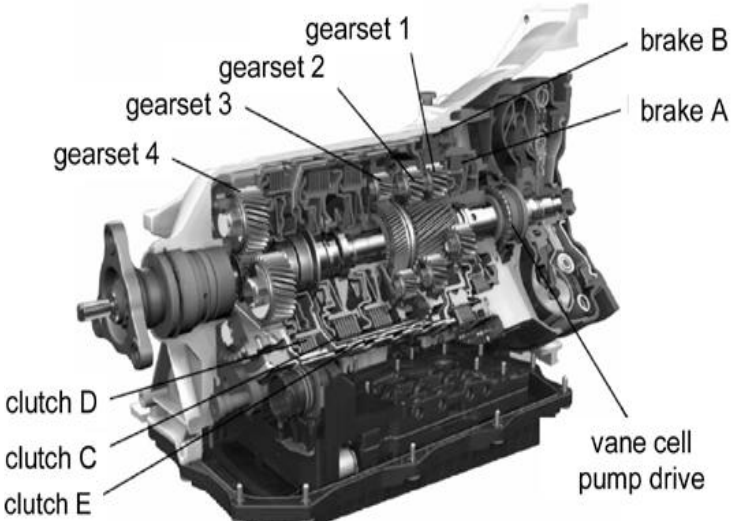


Fig-5: The 8-speed transmission is based on a gear set system with 5 shifting elements and 4 planetary gear sets; the overall gear spread is 7.05.

(D) Electric Transmissions: These have been used for higher capacity dumpers. Engine is coupled to invertor that is again connected to the wheel motors. It is a combo unit with planetary gear train for getting higher torque. Each wheel motor drives a sun pinion that turns a central sun gear and three planetary gears. The gear set is enclosed in a gearbox and lubricated with gear oil (Fig-6). In EV's the transmission fluid comes in contact with copper windings, insulations, laminates and rare earth materials in motors so its lubricant film is quite challenging.

Fig-6: Electric drive of an off-highway, high-capacity dumper

(E) Hydrostatic Transmission (HTS): It works on the principle of Pascal's law i.e. pressure exerted at any point on a confined fluid is transmitted undiminished throughout the fluid in all directions. Some of the applications are in automobiles, excavator in mining, agriculture & construction machinery.

(F) Final Drive: uses a set of "**planetary gears**" (sun-and-pinion gear system) to convert force into torque, it allows the combination of sun pinion, planetary gears, ring gear & carrier to deliver power. The double reduction process further multiplies the torque in heavy duty application.

(G) Industrial Reduction Units: It's a combination of—i) "**spur gearing**"—whose axes are parallel, 'rack and pinion' (for converting rotary to reciprocating motion & vice versa), 'helical' gearing and 'herringbone' gearing (herringbone are to take up the end thrust/axial load & smooth-silent operation). ii) "**bevel gearing**", which is used for connecting the intersecting shafts e.g. straight bevel gears, 'miter', 'crown' & 'spiral' gears. iii) gearing for shafts whose axes are neither parallel nor intersecting axes consisting of "**worm and worm wheels**" (worm resembles a screw having number of threads which connects to wheel having teeth cut at its outer periphery) are used for a large speed reduction or a high increase of torque by means of worm gears.

Tribology Aspects for Reducing the Energy Losses from Transmission

The working principle of gear implies the presence of a loaded sliding & rolling contact condition. The contact implies the presence of several failure modes, such as tribological damages (i.e. scuffing, scratching, wear & rust) and fatigue damages (e.g., macro/micro-pitting, tooth flank/ fatigue fracture). Maximum deterioration of gears takes place on the surface of gears as teeth are responsible for power transmission. For noise sensitive applications, nonlinear materials like polymer with lower stiffness and good damping characteristics are preferred. The part of the fuel energy is converted into mechanical power '**to overcome friction**'. As per the published studies, losses are ~13% in the transmission system. The friction loss in a gearbox occur in the rolling bearings, gears, gear synchronizers, shaft seals & partly in the oil churning inside the sump in an automobile.

Efforts of reducing friction:

a) For the strength & surface hardness, heat treatment is used such as hardening, carburizing or case hardening, nitriding, induction & flame hardening etc.

b) Low-Friction Coatings on Mechanical Components

The surface coating technology has shown the major improvement in reducing the friction losses over few decades e.g. **Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD),** and **Thermal Spraying (TS)** in industrial & automotive components to enhance their residual life. The role of a coating is then to work as a safety layer. The lifetime improvements achieved using surface coatings have been impressive e.g. a three-fold increase in gear lifetime have been reported by the experts.

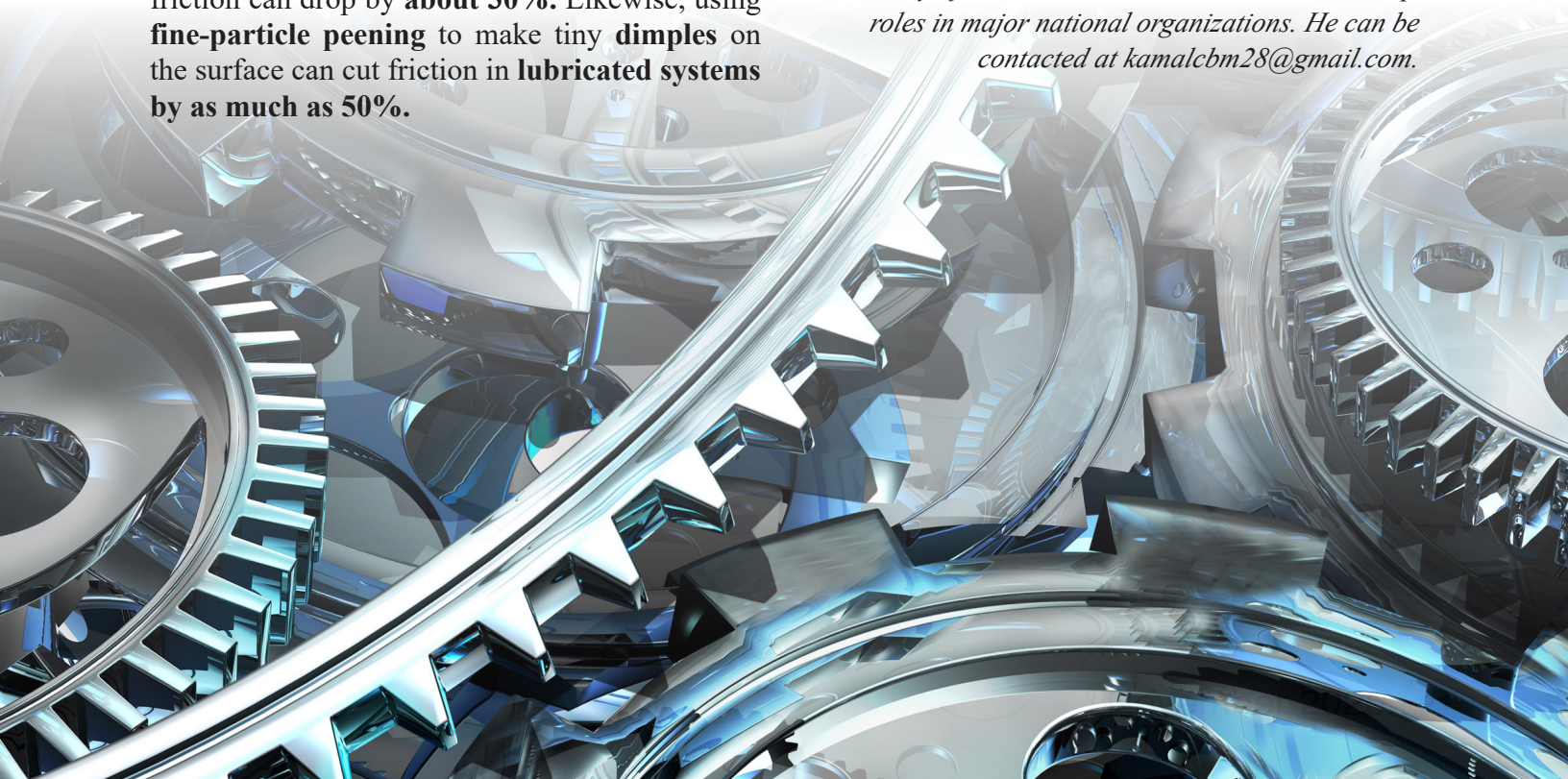
Scientist have found that by using **Diamond-like carbon (DLC)** coating as against the standard steel-to-steel contact resulted in **~30% reduction in friction.** Further, by applying **tungsten carbide/carbon (WC/C)** coatings in FZG gear tests, about **70-fold increase in lifetime** was obtained. Similarly other **composite coatings** within Si_3N_4 or **SiC ceramic matrices,** & various **nanostructured coatings,** have given potential friction reduction.

c) Recent research shows that when gear surfaces are made smoother using **superfinishing,** friction can drop by **about 30%.** Likewise, using **fine-particle peening** to make tiny **dimples** on the surface can cut friction in **lubricated systems by as much as 50%.**

d) Lubricants: The lubricant has several functions—i) provides a fluid film between load-carrying and fast-moving components, assuring that shear takes place within the lubricant with low friction, and that solid contacts are avoided, ii) helps to form a chemical film on surfaces to avoid wear and breakdown, iii) prevents corrosion, iv) provides cooling by heat transport, and v) transports contamination away from the system. However, oil churning results in energy losses due to the viscosity of the lubricant. The use of lubricating oils of lower viscosity will reduce the energy losses from viscous work. A reduction of the engine oil viscosity by approximately 25% corresponds the fuel savings for a similar lowering of the viscosity of a gear oil is on the order of 0.2–2.5%. Another issue for gearboxes lubrication is to retain efficient lubricant boundary throughout their life. Additive e.g. friction modifiers, anti-wear, extreme pressure & nano particles help to maintain the proper film of lubricants in the gear surfaces.

Keeping perspective of long and reliable service, tribological needs must be identified and addressed at early transmission design stages always outperform many low-cost motion solutions in market. ◆

***Kamal Mukherjee**, a prolific science writer and nutritionist, is an active member of the Tribological Society of India and has held executive leadership roles in major national organizations. He can be contacted at kamalcbm28@gmail.com.*



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Vegetarianism for Children: A Scenario

Sudipta Banerjee, Barnini Bhattacharya, Sharanya Mukherjee, Neepa Banerjee, Sandipan Chatterjee, Shankarashis Mukherjee

Human beings have been experiencing different eating habits, improvising themselves from time to time in relishing more and more diverse tastes of their platter, by shifting from hunting and gathering style to culinary and gastronomic innovations at recent times. The famous saying—"you are what you eat and you eat what you are" dates back to ancient religious texts which are a source of building ethical framework in mankind. The oldest texts of Hinduism capture the ultimate goal of life of *atman* (soul) to connect with the Divine entity, which necessitates the cessation of the vicious cycle of birth and death, ending entanglements of *karmic* (good and bad actions) reactions and following different processes of *yoga.* The concept of *karma* spread to other branches of religions like Buddhism and Jainism and more stricter rules of liberation were set. The advent of vegetarianism is linked to the same framework of moral conduct where abstinence from violence is considered a means of maintaining inner and outer harmony and a way to come out of sinful reactions of atrocities that will be created by slaughtering animals for food [1]. A report states that India inhabits largest population of vegetarians (about 38%) in the world in 2023. Its religious inclinations, family and cultural traditions play a major role in shaping the dietary habits among the citizens generations after generations. However, today apart from religious wisdom, there are other reasons of people turning to plant-based foods – climate awareness, increasing prevalence of chronic health disorders, compassion and economic reasons to name some. This picture is not only relevant in India but throughout the world. More and more people are turning to plant-based diets are found to be affirmative in future because mindfulness in behavior towards reducing animal suffering, climate change and sustainable approach is evident among the population globally [2].

The Earth's climate is getting transformed throughout the decades affecting the environment in its worst. The Global warming happens when greenhouse gases, majorly CO_2, emitted in the environment by exhaustive processes like burning of fossil fuels, deforestation etc. get piled up in the atmosphere, hence trapping the heat and raising the temperature of the Earth. This results in recurring natural disasters and hence loss of properties which are frequent events throughout the world lately. Actions are recommended

at individual levels like turning towards cleaner electricity sources, opting for public transport, opting a greener diet and reducing food waste can save up to 500 kgs of carbon-dioxide emissions. The changing climate is more likely to affect the developing countries pushing them into the darkness of extreme poverty and in the situation of depleted essential resources by the next few decades under prevailing conditions. Hence the COP29 of the United Nations, in 2024, focused on assisting the weaker countries with about $300 billion every year by the well-off countries to accelerate the task of reducing CO_2 emissions. The ongoing warming is undeniably affecting the children putting a question mark on their future security of life. Increasing episodes of heatwaves and consistent breakouts of daily highest temperature records have already manifested with more locking of schools in summers that harms the academic efficiency of children. Persisting poor air quality index scores also threatens children's health as they are more vulnerable towards infections and allergies due to immature immune responses during growth phases. The UNICEF reports in that the climate change makes the education attainment of about 40 million youngsters endangered, more than 700 million of them are exposed to water scarcity and more importantly malnutrition will be one of the most prominent problems due to food insecurity and crop failures. Despite of all these statistics and events, there are least efforts in action towards attaining a net zero environment for generations to come. Rather than keeping the children as victims, awareness among the youth by deliberate education, inspiring the young voices to raise opinions as been seen in some countries like Sweden, Portugal, US, where the youth have endeavored to advocate legal significance in collective attempt in mitigating catastrophic scenario, etc. are in utmost need [3].

In terms of nutrition, the effectiveness of vegetarian diets in fulfilling the nutritional needs were on dais of research question since decades. It has been found that vegetarians also have different lists of dietary prescriptions, which classify them into categories like lacto-vegetarian (who say no to meat of all kinds and eggs but yes to milk), Ovo-vegetarian (who say yes to eggs only), ovo-lacto-vegetarians (who say no to meat but yes to eggs and milk), Pescetarian (who say yes to fishes and seafood but no to meat, eggs and milk), flexitarian (who say yes to animal based foods occasionally) and vegans (who only munch on plants). Although plant-based diets are suitable to reduce health risks but lack of proper planning due to inadequate knowledge can lead to multiple nutritional deficiencies. Major concerns are regarding vitamin B12, vitamin D, iodine, calcium, selenium and iron. Vitamin B12 is produced by microorganisms within the gut and is also available in animal food products including dairy. It is important to maintain functions of central nervous system, needed for formation of red blood cells and brain development in children and aids in DNA synthesis. However, eggs and

milk are inadequate to meet its daily needs, hence those who are vegetarians are more prevalent and vegans are the most prone towards vitamin B12 deficiency and must rely on supplementation under expert guidance. Vitamin D is another important nutrient that has its role in bone metabolism, it helps in calcium absorption from intestine and mediates in immune function. It is naturally produced subcutaneously under the Sun exposure but nowadays modern lifestyles restrict enough outdoor time hence become at risk to deficiency. Prevalence of vitamin D deficiency is considerably high, falling in the range of 70-80% among adults and 90-100% among vulnerable groups like pregnant and lactating women and infants across the entire Indian subcontinent. The degree of deficiency depends upon the kind of animal product restricted, vegans being 16 times more prone to deficiency than omnivores. Iodine is another vital nutrient essential for thyroid health and affects the associated functions of thyroid hormones like metabolic regulation, growth and neural development. Although vegetarians and vegans are at risk for developing iodine deficiency but almost 92% of Indian households has access to iodized salt marketed widely across the country which has successfully managed to prevent iodine deficiency among its citizens. However, precautions are necessary to ensure proper intake of iodine. Calcium is necessary for bone growth and muscle metabolism and vegetarians develop deficiency of calcium substantially. More than 70% of vegans also remain calcium deficient. Although leafy greens are good sources of calcium but high content of oxalic acid and phytic acid reduces the bioavailability of calcium to 20-30% only. Reliance on dairy, calcium fortified plant-based milk are solutions suggested to look for before opting any supplementation regime. Iron is the absolute component of hemoglobin and myoglobin, also helps in erythropoiesis, DNA synthesis and immune functions. Deficiency results in microcytic anemia, causes cognitive impairment and increases susceptibility to infections. Plant-based foods are rich in iron equally as in animal-based foods but vegetarians are more prevalent for anemia compared to meat eaters, as iron in plants are less bioavailable due to the presence of phytates and polyphenols. Iron in plants are in ferric (Fe^{3+}) form which gets converted to ferrous (Fe^{2+}) form to get absorbed in the gut. Whereas animal foods contain iron in ferrous form and hence easy to digest. Also, vitamin C aids in iron absorption hence people are advised to take vitamin C rich foods to assist in iron absorption [4].

It is obvious that vegetarian and vegan families are having children who grow with the above-mentioned dietary restrictions. As per NFHS 5 (National Family Health Survey 5) reports, more than 65% of the children under 5 years of age are suffering from anemia and the prevalence of underweight and stunted children is more than 30%. Nutritional status and thereby the growth outcomes of children is determined by the kind of food they have. Studies found that compared to omnivorous children, vegetarians

and vegans are shorter and at risk for underweight due to higher probabilities of deficiencies. However, although vegans have low risk for cardiovascular infirmities than vegetarians, but in terms of nutritional deficiencies, vegans show more pronounced scarcity than vegetarians [5], keeping them at high risk of deficiency disorders like rickets and anemia. Mothers also reported to have experienced social discrimination and criticism regarding acceptance of vegetarian and vegan diets for their children. Whereas, there are also studies that report similar growth among vegan, vegetarian and omnivorous children whose macronutrient intake levels and growth metrics were comparable, reflecting similar growth outcomes in them. Only few researches have been done regarding cognitive development in vegetarian children. Risk of iron and vitamin B12 deficiencies may make them susceptible towards cognitive impairments. Studies done in German students and British adults have found no substantial association between eating habits and mental health. Neither eating habits has any association with emotional expressions. Studies report that consumption of diets allowing one or more of animal sources can be made more nutritionally complete without supplementation amongst all other restrictive diets and its consumption will not substantially blunt the health of children [6]. Due to lack of enough evidence for growth outcomes of plant-based diets in children it is not perfectly decisive about its suitability. Nevertheless, vegetarian diets allow either of animal sources in their composition and hence are less risky compared to vegan diet that completely avoid animal sources.

Keeping in mind the high nutritional demands for children during their growth periods it is required to ensure taking professional help or strengthen the basic nutritional knowledge in order to maximize the growth potentials of the youngsters as well as adopting a climate friendly life by holding back the ancient Vedic legacy. ◆

References

1. Sen, T.C.: Feasts and Fasts: A History of Food in India. Speaking Tiger Books LLP. (2015). ISBN: 978-93-85755-34-7.
2. Leitzmann, C. (2014). Vegetarian nutrition: past, present, future123. The American journal of clinical nutrition, 100, 496S-502S.
3. Sanson, A.V., Hoorn, J.V., & Burke, S.E.L (2019). Responding to the impacts of the climate crisis on children and youth. *Child Development Perspectives,* 13(4), 201-207. DOI: 10.1111/cdep.12342
4. Gibbs, J., & Cappuccio, F. P. (2024). Common nutritional shortcomings in vegetarians and vegans. *Dietetics,* 3(2), 114-128.
5. Elliott, L. J., Keown-Stoneman, C. D., Birken, C. S., Jenkins, D. J., Borkhoff, C. M., Maguire, J. L., & TARGet KIDS! Collaboration. (2022). Vegetarian diet, growth, and nutrition in early childhood: a longitudinal cohort study. *Pediatrics,* 149(6), e2021052598.
6. Briana, D. G. R., Rivas, A. M. N., & Roldan, M. Á. C. (2025). Anthropometric, dietary, and nutritional outcomes of vegetarian and vegan diets in childhood: A narrative review and recommendations for adequate nutrition. *North African Journal of Food and Nutrition Research,* 9(19), 137-150.

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MIND and MND

Kaartik Gupta

Motor Neuron Disease (MND) is often described as a disorder of movement, but the lived experience is equally psychological. Muscles weaken, yes—but so do routines, roles, and certainties. Under that pressure, families renegotiate identity, meaning, intimacy, and hope. Expanding on the earlier overview, this article takes a deeper look at how mind and MND intersect, what to expect across the course of illness, and how practical, evidence-informed psychological care can sustain dignity for patients and caregivers alike.

A new diagnosis tends to upend time. People oscillate between frantic googling and numbness; sleep becomes erratic; meals are skipped; small tasks feel pointless. This stage is not pathology—it is adjustment. Three anchors help:

- **Orientation without overwhelm:** A clear summary of "what we know, what we don't, and what we'll monitor" reduces the sense of free fall. Clinicians should translate medical terms into everyday language and state the next two or three actions only (e.g., physiotherapy assessment, swallowing screen, introduction to a support group).
- **Rituals that keep the day stitched together:** Fixed wake/sleep times, brief morning light exposure, regular meals, and a short daily walk or stretch maintain circadian rhythm and mood.
- **A coping map:** Patients note three helpful habits (e.g., prayer, journaling, calling a friend) and three unhelpful spirals (doom-scrolling, skipping meals, arguing late at night). The aim is not perfection; it is noticing and nudging.

Depression and anxiety are frequent, understandable responses. Grief recurs with each loss of function—"living loss"—and does not obey tidy stages. Most people improve when sleep, pain, and practical supports are addressed. Seek professional help if any of the following persist beyond a few weeks: pervasive sadness, loss of interest, hopelessness, significant weight change, severe guilt, panic attacks, or thoughts of self-harm. Treatment options include:

- **Cognitive-Behavioural Therapy (CBT):** Challenges catastrophic thinking ("I'm a burden," "Nothing will help") and pairs it with behavior change: energy-matched activity planning, pleasant-event scheduling, graded exposure to avoided tasks (e.g., short public outings with mobility aids).
- **Acceptance & Commitment Therapy (ACT):** Builds skills to carry difficult emotions while continuing to act on values—connection, creativity, faith, service. Helpful when symptoms cannot be "fixed" but life can still be chosen.
- **Medication:** When indicated, antidepressants and anti-anxiety medicines can be effective. Start low, go slow, and review for interaction with respiratory status and daytime alertness.

A subset of people with MND develop cognitive or behavioral change—slower thinking, trouble planning, impulsivity, apathy, emotional blunting, or loss of empathy. Families may misread these as "stubbornness" or "not trying." Early screening prevents conflict and guides safety decisions (e.g., driving, finances). Practical responses:

- Use **simple, concrete steps** instead of multi-stage instructions.

- Prefer **external scaffolds:** calendars, alarms, checklists, labeled drawers.
- Keep **choices limited** ("this or that?" rather than open-ended).
- Involve a psychologist or neuropsychologist for targeted strategies and capacity assessments when major decisions arise.

Sleep disruption—due to anxiety, cramps, position changes, or early respiratory compromise—drives daytime fatigue and low mood. Basics first: regular sleep window, minimal noise/light, no phones in bed, caffeine cut-off 7–8 hours before bedtime, a warm rinse and 10 minutes of breathwork or progressive relaxation. If morning headaches, non-restorative sleep, or witnessed pauses in breathing occur, ask about **nocturnal hypoventilation;** non-invasive ventilation can dramatically improve energy and cognition. Pacing matters: alternate activity and rest, cluster errands geographically, and pre-book "recovery slots" after clinic days.

Communication is more than speech—it is identity and control. Even before speech weakens, introduce tools:

- **Low-tech:** yes/no cards, alphabet boards, topic cue cards.
- **Voice banking:** record phrases while speech is strong; later, synthesized speech can sound like "you."
- **AAC devices:** from smartphone apps to eye-gaze systems. Start training early so tools feel familiar before they are essential.
- **Conversation hygiene:** one person speaking at a time, facing the listener, short phrases, confirm key points, avoid background noise.

MND reorganizes the household. Partners juggle employment, caregiving, and finances; children observe distress they cannot decode; elders worry about costs and honor. Noticing caregiver strain is itself a clinical task. Red flags include sleep debt, irritability, somatic complaints, isolation, and a sense that "nothing I do is enough." Support includes skills training (safe transfers, energy conservation), scheduled respite (even two hours weekly helps), peer groups, and transparent discussions about intimacy, privacy, and roles. Reassure caregivers: **resentment is a signal of overload, not a moral failure.**

Physiotherapy and occupational therapy become more effective when paired with psychological goals. Instead of generic exercise, anchor movement to **personally meaningful outcomes:** "walk to the garden with my daughter," "sit on the balcony for tea," "attend temple once a month." Motivational interviewing techniques help set realistic, values-based targets. Track progress with micro-metrics—metres walked, stairs climbed, minutes on the balcony, number of weekly outings—so improvements remain visible even when disease fluctuates.

Pain and cramps discourage activity and worsen mood. Treat both the symptom and the meaning assigned to it ("pain means I'm declining rapidly" → "pain means I must review stretching, hydration, and meds today"). Pseudobulbar affect—sudden, disproportional laughing or crying—can be socially disabling yet responds to medication and psychoeducation. Explaining to family and friends that these episodes are brain-signal mismatches, not insincerity, reduces embarrassment and isolation.

In India, distance, language, and stigma can block access. Many families first seek help from informal healers or avoid mobility aids due to perceived "defeat." Practical adaptations help:

- **Regional-language education** materials and videos for patients and carers.

- **Tele-psychology** check-ins for those far from tertiary centers.
- **Community physiotherapy camps** and partnerships with local colleges for caregiver training.
- **Low-cost home changes:** rails, non-slip mats, decluttering, raised toilet seats, bed-side commodes, portable ramps.
- **Financial planning early,** including disability certificates, government schemes, and crowdsourcing guidance where appropriate.

Desire and intimacy do not end with diagnosis. Fatigue, body-image shifts, and practical barriers can. Normalize conversation. Adjust timing (earlier in the day), positions (to reduce breath strain), and expectations (focus on closeness and touch, not only intercourse). Acknowledge grief when roles change from partner to caregiver; both can coexist. When needed, a counselor can mediate difficult conversations gently.

Advance care planning prevents crisis-driven decisions. Discuss preferences for feeding, respiratory support, admission thresholds, and the place of care. Clarify who speaks for the patient if decision-making capacity is lost. Document choices in language the family understands; revisit periodically. This is not "giving up"—it is **protecting the person's voice** for the future.

A stepped psychological care pathway

Step 1: Baseline (first month).

- Screens: PHQ-9 (depression), GAD-7 (anxiety), brief cognitive screen; sleep and fatigue checklist; caregiver strain index.
- Foundations: orientation, day-structure, sleep hygiene, safety review, first physiotherapy plan.
- Connections: support group link, tele-follow-up schedule, WhatsApp helpline hours.

Step 2: Consolidation (months 2–6).

- Weekly CBT/ACT-informed sessions or structured check-ins.
- Communication plan (voice banking/AAC), home modifications, mobility aid acceptance.
- Track four micro-metrics (e.g., metres walked, outings/week, hours of restful sleep, enjoyable activities/week).
- Caregiver respite plan and skills training.

Step 3: Maintenance and adaptation (beyond 6 months).

- Monthly reviews; crisis plans for infections or falls.
- Re-assess mood, anxiety, cognition each quarter; adjust meds/therapy.
- Revisit goals of care; prepare paperwork; update contacts.
- Celebrate continuity: birthdays, family rituals, small trips, projects (photo albums, oral histories).

Aarav, 42, engineer. Terrified of "becoming a burden," he stops meeting friends. CBT reframes the burden belief; activity pacing plus a portable stool lets him attend his child's cricket match for 30 minutes. He records his voice for future AAC, which paradoxically reduces anxiety now. PHQ-9 drops from 15 to 6 over eight weeks.

Meera, 58, teacher with mild frontal changes. Family fights over finances and driving. A capacity assessment shows poor risk judgment; keys are removed, and online banking is switched to joint control. A whiteboard task list and pillbox reduce daily friction. The family interprets apathy as disease-related, not laziness; conflict eases.

Standard scales (ALSFRS-R, 6-Minute Walk Test, Timed Up-and-Go) are useful, but **patient-defined indicators** keep motivation alive: "number of evenings on the terrace," "calls with my sister," "pages of my memoir," "times I prayed in congregation," "home-cooked meals enjoyed." Plotting these on a simple chart transforms invisible effort into visible achievement.

A compact toolkit

- **Daily:** fixed wake time; sunlight (10–15 min); one valued activity; 10 minutes of breathing/mindfulness; fluids and protein with each meal; tech-free wind-down.
- **Weekly:** one social contact, one enjoyable outing, caregiver respite slot, check home safety.
- **Quarterly:** mood/anxiety/cognition screen; review goals of care; audit equipment and home modifications.

OVIHAMS (Om-Vidya Institute of Homeopathy & Allied Medical Sciences) runs an **integrated pathway** for people living with MND

that pairs individualized homeopathic prescribing with physiotherapy, occupational and speech therapy, nutrition counseling, sleep hygiene, and structured psychological support. The emphasis is pragmatic and measurable:

- **Person-centred metrics** at every visit (walking distance, stairs climbed, sleep quality, fasciculation intensity, daytime energy, mood/screen scores).
- **Home-safety audits** and caregiver coaching to reduce falls and friction.
- **Medication stewardship** alongside homeopathic care (e.g., timely referral for NIV, cramps/pain management, pseudobulbar affect).
- **Documentation discipline** that turns lived changes into trackable graphs so families can *see* progress.

Clinically, many patients report improvements in sleep continuity, anxiety management, cramps, nausea, urinary discomfort, and activity pacing; several regain meaningful mobility with concurrent physiotherapy and nutritional repletion. These outcomes are **case-based and observational**—they do not prove disease modification—but they do show how homeopathy can be combined responsibly with standard rehabilitation to support comfort, adherence, and day-to-day functioning. OVIHAMS advocates **evidence-seeking practice:** wherever feasible, the team proposes **N-of-1 designs** (alternating treatment/washout blocks with standard measures like ALSFRS-R, 6-Minute Walk, Timed Up-and-Go, hand-grip strength, sleep/fatigue scales, and surface-EMG counts) to turn single-patient journeys into analyzable learning without sacrificing individualization.

Shanti Foundation partners with OVIHAMS to make MND care **visible, understandable, and reachable.** The foundation:

- Produces **multilingual educational content** (print, video, community talks) to reduce stigma and promote **early symptom recognition.**
- Runs **caregiver training modules**—safe transfers, pacing, basic physio, communication supports, sleep hygiene—through colleges/NGOs in Hindi, Bengali, Tamil, Kannada, and English.

- Pilots **low-cost rehab kits** (rails, non-slip mats, resistance bands, spirometry education leaflets) and connects families to financial assistance where possible.
- Encourages **measurement culture** (simple logbooks/phone forms) so small wins are recorded and shared with the clinical team.
- Supports **practice-based research** with OVIHAMS by helping design N-of-1 protocols, consent processes, and outcome dashboards—so community care adds to the knowledge base.

MND may be a disease of motor neurons, but it is lived in stories: tea on a balcony, the sound of a familiar voice, a grandchild's laughter, evening prayers, a page of memories. Psychology's task is not to deny decline, but to protect meaning—by reducing fear, organizing days, strengthening relationships, and keeping choices visible. When multidisciplinary medicine meets compassionate, measurement-minded psychological care, people do more than endure. They adapt, connect, and continue to author a life—one measured, mindful step at a time. ◆

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Innovation in Dementia Care

Subodh Kumar

Dementia—an umbrella term for conditions that impair memory, judgment, language, and social functioning—has quietly become one of the defining public health challenges of our century. It is not a single disease but a cluster of syndromes rooted in brain disorders such as Alzheimer's disease, vascular dementia, dementia with Lewy bodies, and frontotemporal degeneration. Age is the strongest risk factor, yet dementia is not an inevitable part of growing older: genetics, head injury, cardiovascular health, mood disorders, sensory loss, education, and lifestyle all shape risk and trajectory. Worldwide, more than 55 million people live with dementia today, a number projected to reach 139 million by 2050. India alone may count around 8.8 million people with dementia in 2025, with cases expected to nearly triple by mid-century. These figures are not just statistics; they are families, friendships, and livelihoods being stretched to their limits—proof that a humane, scalable response can no longer be deferred.

For decades, dementia care was largely reactive and behavior-focused. Agitation, wandering, and withdrawal were treated as problems to be subdued rather than messages to be understood. The newer, science-grounded paradigm sees these behaviors as communication from a brain struggling to process its surroundings. From that lens, the task of care becomes translation and support: reduce noise and fear, increase safety and familiarity, and spark retained abilities. Early and accurate diagnosis helps enormously. Biomarkers, advanced neuroimaging, and artificial-intelligence decision support are improving clinicians' ability to distinguish Alzheimer's from frontotemporal or Lewy body disorders, and to recognize mixed pathologies. Better labeling leads to better planning—tailored non-pharmacological approaches, safer medication choices, and honest conversations about prognosis.

Equally important, non-drug interventions have matured from "nice to have" into core therapy. Cognitive Stimulation Therapy, structured reminiscence, multisensory activities, music-based engagement, and supported physical activity can slow functional decline and brighten daily life. When delivered consistently, these approaches reduce behavioral distress, lighten caregiver burden, and sometimes diminish the need for sedating medicines. They also restore something that often goes

missing after diagnosis: a sense of agency for the person living with dementia.

Technology, once a distant promise, is now a practical partner. Smart home ecosystems—with unobtrusive sensors, context-aware reminders, and fall detection—make independence safer without smothering dignity. Lighting that shifts with circadian rhythms reduces "sundowning." Wearables track sleep, activity, and hydration. Virtual reality and immersive media can evoke cherished places and memories, lifting mood and sparking conversation. AI-powered assistants help with structure and communication, while caregiver apps offer coaching, symptom trackers, and peer communities that soften isolation and burnout. The trick is not to chase gadgets but to choose tools that are reliable, affordable, and easy for families to use in the languages they speak.

Residential care is also being reimagined. The most successful centers feel like small households rather than institutions. Residents can stroll along safe-wandering paths, enjoy shaded courtyards, and follow visual cues that make navigation intuitive. Bedrooms are personalized with familiar objects; kitchens smell of actual food; daily routines resemble the life a person led before. Staff are trained to interpret behavior, not merely manage it. This "small-home" model—already reflected in progressive memory-care units within assisted-living communities—focuses on remaining abilities, not losses. It recognizes that architecture, routines, and relationships are therapeutic in their own right. Initiatives like those championed by VataVriksh Senior Care show how clinical competence, environmental design, and community ethos can coexist to honor personhood.

Yet none of this will reach every household unless dementia is treated as a national priority that cuts across health, social care, finance, housing, and technology. A modern response begins with a long-horizon National Dementia Strategy—10 to 15 years in scope, implemented through rolling three- to five-year operational cycles. Such a plan should cover prevention, screening, diagnosis, treatment, long-term support, caregiver respite, and end-of-life care. It should be anchored by a program office within the health ministry and include representation from social justice, rural development, women and child development, housing, information technology, and finance. Time-bound targets would make it real: screening

70% of adults aged 60 and above within five years, shrinking the median time from first symptom to diagnosis below 90 days, establishing at least one dementia care hub in 80% of districts, and certifying 50,000 dementia-trained workers. Financing must blend public insurance, social-care budgets, and philanthropic/private partners, with specific reimbursement codes for cognitive assessment, caregiver education, respite services, and home-based support. National standards—clinical pathways for diagnosis and management; design guidelines for dementia-friendly homes and facilities; and accreditation for memory clinics and residential units—would set clear expectations. Public awareness campaigns in multiple languages should run annually, reducing stigma, promoting brain-healthy lifestyles, and normalizing help-seeking.

Data is the backbone of good policy, so this strategy needs a companion: a secure, privacy-preserving National Dementia Registry. By drawing de-identified data from primary care, memory clinics, hospitals, residential facilities, home-care agencies, and voluntary patient portals, the registry would track incidence, subtypes, comorbidities, treatments, outcomes, and caregiver stress. Real-time dashboards would help planners spot service gaps and benchmark quality; researchers could identify cohorts for trials; and the public could see honest, annual scorecards. Guardrails matter: robust consent models, citizen and ethics oversight, data minimization, and clear governance are essential for trust.

Service delivery must be integrated rather than fragmented. Primary care should become the front door, embedding brief cognitive screening and risk-factor management—hypertension, diabetes, depression, hearing loss—into routine elder care. Decision-support tools can guide family doctors and nurses through next steps. A tiered referral network then funnels people to memory clinics for diagnosis and care planning, with regional hubs handling complex cases, neuroimaging, and multidisciplinary input from neurology, geriatrics, psychiatry, rehabilitation, and social work. Home- and community-based supports—day-care centers, respite beds, caregiver helplines, mobile memory teams, and tele-consults—extend reach to rural and underserved areas. When home becomes unsafe or exhausting, small-household residential options with safe wandering, personalized cues, and meaningful daily activities should be available, paid for in ways that reward quality rather than occupancy alone.

This vision stands or falls on workforce development. A tiered pipeline can bring many hands to the task. Community dementia companions can learn foundation skills for home activation, safety, and respite. Dementia care assistants can add training in activities of daily living, behavior management, and structured stimulation therapies. Specialist roles—nurse practitioners, psychologists, occupational and speech therapists, social workers, geriatricians—complete the ladder. Training should be modular and stackable, with national certification and widespread access through digital academies, simulation labs, and mandatory dementia modules in nursing and medical curricula. Retention demands fair wages, career paths, mental-health support, and recognition programs to reduce burnout and turnover.

Families deserve protection and practical help. Entitlements could include paid caregiver-leave pilots, micro-grants for home modifications, subsidized respite days, transport vouchers, and facilitated peer-support groups. Education—offered in local languages both online and in person—should cover communication, managing behavioral and psychological symptoms of dementia, nutrition, fall prevention, and medication safety. Clear pathways for advance care planning and powers of attorney would prevent crises and exploitation.

Technology and innovation must be pursued with an equity lens. A national "sandbox" can evaluate remote cognitive tests, wearables, fall detectors, and wander-safety tools against common standards for accuracy, usability, privacy, and inclusion. Open APIs should allow, with consent, sensor feeds and clinic records to integrate into personalized care plans and the national registry. Device-loan programs, offline-capable apps, and community digital navigators can ensure rural and low-income households are not left behind.

Local research should answer local questions: How can we deliver low-cost diagnostics at scale? Which culturally adapted non-pharmacological therapies work best in diverse Indian communities? What is the true economic value of caregiver time, and which supports prevent hospitalizations? Earmarked grants, pragmatic trials embedded in public systems, and rapid-cycle evaluations can accelerate learning. Toolkits, playbooks, and open datasets will help states and NGOs replicate what works.

All action should be framed by safeguards, ethics, and dignity. People living with dementia have the right to safety, autonomy, and participation in community life. Anti-discrimination policies in healthcare, housing, and employment; dementia-friendly certifications for banks, transit, marketplaces, and places of worship; and routine access to palliative and end-of-life care are not luxuries—they are the test of whether our systems see the person before the diagnosis.

If pursued with clarity and compassion, this approach can deliver tangible milestones within five years. A national strategy and registry would be in place, with 100 district pilots running and an annual, multilingual public awareness campaign. Primary-care screening could become universal in pilot states; 500 memory clinics could be operational; and at least 25,000 dementia workers certified. By year five, the time from diagnosis to a documented care plan could fall to 30 days in most districts, respite access could be guaranteed nationwide, and avoidable hospitalizations measurably reduced.

The dawn of dignity in dementia care is already breaking. Its light will reach every home when science, systems, and society move in step: when the clinic listens before it prescribes; when technology simplifies rather than overwhelms; when care settings feel like home; when families are supported, not abandoned; and when the nation affirms, in policy and practice, that people living with dementia—and those who love and care for them—are entitled to safety, autonomy, relief from suffering, and a full place in our communities. Building that future is not merely a medical project. It is a choice about the kind of country we intend to be. ◆

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When Money Grows on the Tree?

Vaithianathan Kannan

Imagine a world where money grows on trees—every leaf a note, every forest a vault. It sounds fanciful, yet forests already mint the wealth that sustains life: clean air, water security, fertile soils, stable climate, and biodiversity. In an age of climate anxiety, treating afforestation and ecosystem conservation as core economic strategy is not idealism but common sense. The value of a forest cannot be summed up in cubic metres of timber; its real dividends appear in food security, disaster protection, public health, and livelihoods. When we invest in forests, we invest in resilience—and yes, in wealth.

The Historical Roots of Forest Prosperity

Across civilizations, forests have underwritten prosperity. The Indus Valley fostered agroforestry; Vedic India revered sacred groves; many tribal communities still treat forests as kin. History also records the price of devastation: deforestation contributed to ecological collapse in regions of Mesoamerica, Mesopotamia, and North Africa. Today, the same warning resounds from the Amazon to the Sundarbans. India's sacred groves (Devrais) in Maharashtra and Meghalaya—pockets of ancient biodiversity protected by tradition—prove that conservation is not a modern import but an indigenous ethic with enduring economic wisdom.

Afforestation: Planting Prosperity

Afforestation—growing trees on barren or degraded lands—turns idle terrain into living capital. India's National Afforestation Programme and Green India Mission aim to restore ecosystems while creating rural jobs. Forests provide far more than timber: non-timber forest products (NTFPs) like fruits, honey, resins, medicinal plants, fodder, and fuelwood can contribute a majority share of household income for forest-dependent communities. Carbon markets add another revenue stream as new forests sequester CO_2. Ethiopia's "Green Legacy," with billions of trees planted since 2019, shows that ambitious, climate-smart planting can scale ecological and economic returns.

Urban afforestation is rising too. Dense, fast-growing "Miyawaki" mini-forests in cities such as Delhi, Bengaluru, and Chennai improve air quality, reduce heat, raise nearby property values, and offer mental-health benefits. Properly designed, a hectare of trees becomes more than land—it becomes long-term, appreciating green infrastructure.

Ecosystem Services: Nature's Invisible Economy

Forests quietly perform services that keep economies running: filtering air; recharging groundwater and regulating river flows; preventing erosion; replenishing soil through leaf litter; stabilizing climate by storing carbon; and supporting pollinators essential to agriculture. Attempts to price these services reveal staggering numbers. Global estimates place forest ecosystem services in the trillions of dollars annually. Mangroves, for instance, serve as storm buffers; each dollar invested in mangrove protection can return over ten dollars in avoided flood damage. In an era of rising seas and erratic storms, such "green insurance" is indispensable.

Forests and Community Empowerment

Over 275 million Indians—largely tribal and rural—depend directly on forests for subsistence and income. When local people are co-managers, conservation outcomes improve. Joint Forest Management has shown that shared stewardship regenerates forests and livelihoods. The Forest Rights Act (2006)

strengthens customary rights and supports participatory conservation. Evidence suggests that forests managed by Indigenous peoples and local communities often show higher biodiversity and lower deforestation. Women's groups in many states now run nurseries, organize afforestation drives, and market NTFPs, turning ecological recovery into gender-inclusive development. When forests thrive, communities find food, fuel, medicine, and dignity close to home.

Challenges and Misconceptions

Not all tree planting is beneficial. Fast-growing monocultures—eucalyptus or pine—can deplete water, acidify soils, and displace native species. Effective afforestation prioritizes native, diverse species and restores natural structure, not just canopy cover. Policy bottlenecks—land tenure disputes, weak monitoring, and one-off "plant-and-forget" drives—undermine results. Urban sprawl and linear projects often erode forestlands under the false choice between development and conservation. The real choice is between short-term projects that externalize costs and green development that internalizes ecological truth. Prosperity without ecological accounting is an illusion.

The Way Forward: Policy, Markets, and Innovation

Afforestation and conservation must be treated as macroeconomic policy. India's CAMPA has earmarked tens of thousands of crores for compensatory afforestation; success now depends on transparent, science-based projects with community participation and long-term maintenance. Technology can accelerate progress: drones for aerial seeding, AI for monitoring canopy change and illegal felling, and blockchain for traceable forest produce. Urban planning should embed green corridors, wetlands, and biodiversity parks so cities function as ecological networks rather than heat islands.

Private capital is moving too. ESG investing nudges companies to offset emissions through credible restoration, while CSR funds can back community nurseries, native-species plantations, and mangrove recovery. Internationally, the UN Decade on Ecosystem Restoration and the Bonn Challenge commit countries to restore hundreds of millions of hectares; India's pledge to restore

26 million hectares by 2030 is both ambitious and necessary. The highest returns will come from projects that join native biodiversity, local livelihoods, water security, and climate resilience.

Trees as the Currency of the Future

So, can money grow on trees? If we define wealth as clean air, safe water, fertile soils, stable climate, reduced disaster risk, nutritious food, and cohesive communities—the answer is unequivocally yes. A tree is a compound-interest instrument for life. Planting one writes a cheque to the future; protecting a forest preserves a nation's ecological capital. Afforestation and conservation are not luxuries for good times; they are economic imperatives and moral commitments to intergenerational justice.

The practical recipe is clear. Choose the right species for the right place. Empower local communities—especially women—to lead and benefit. Finance restoration as infrastructure, with long timelines and measurable outcomes. Integrate forests into climate, water, agriculture, and health policy. Measure returns not only in carbon but also in cooler cities, fuller aquifers, richer soils, safer coasts, and stronger rural incomes. In doing so, we align human prosperity with planetary boundaries.

The next time someone says money doesn't grow on trees, invite them to run the numbers on flood protection, pollination, carbon storage, groundwater recharge, and rural livelihoods. Then ask them to breathe deeply. Forests do not mint coins; they mint possibility. Plant wisely, protect fiercely, and the balance sheet of life will remain in the green. ◆

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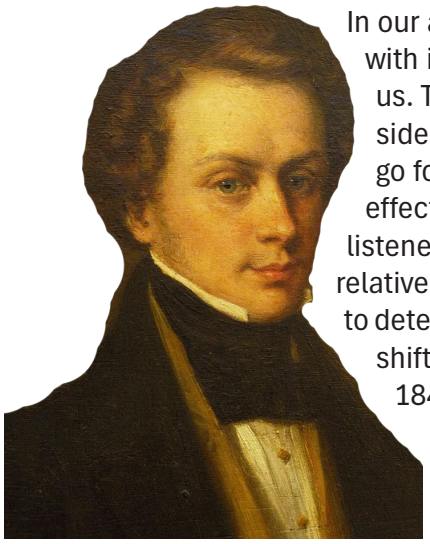
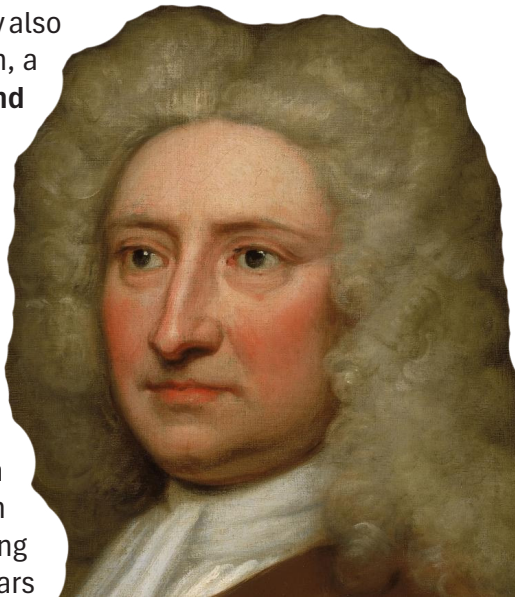
Celebrating the November Born Scientists

Bhupati Chakrabarti

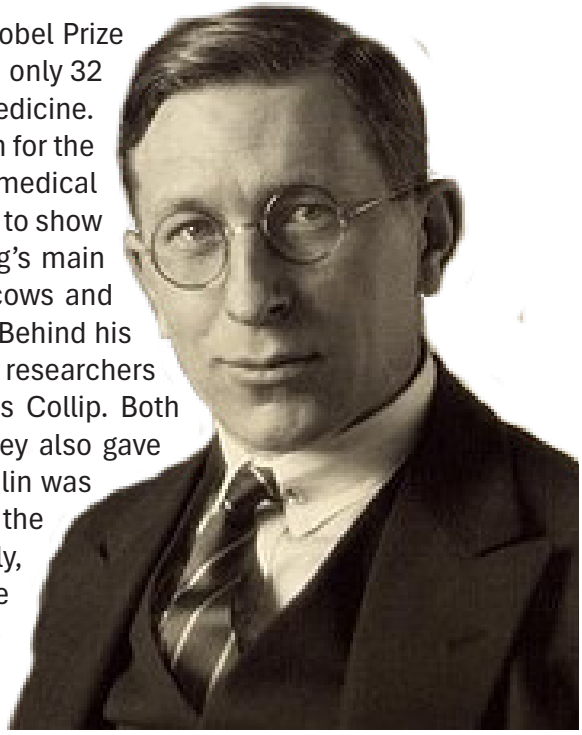
These luminaries, born in the month of November, have each illuminated the path of human progress in their own right. Their discoveries have transcended the bounds of their respective fields, shaping the world as we know it. As we reflect on their lives and legacies, we are reminded of the boundless potential of the human spirit to inquire, innovate, and inspire. Through their work, these scientists have left an enduring legacy, a testament to the power of curiosity and the relentless pursuit of knowledge.



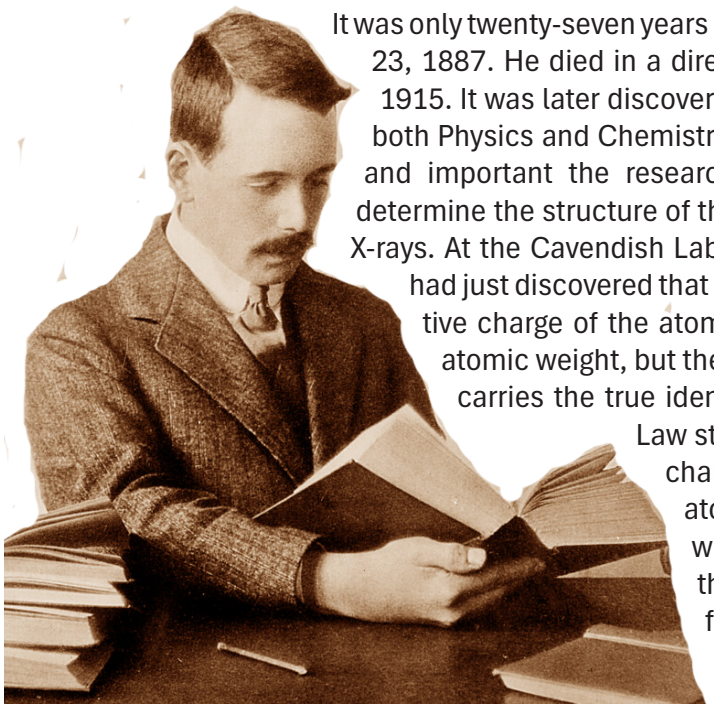
In our almost daily experience, we see how the sharp siren of an ambulance rushing by with its siren blaring becomes somewhat thicker and loses its sharpness as it passes us. The speed of our bus or car is displayed on a special digital board installed on the side of the road. Nowadays, many of us hear the term 'Doppler ultrasound' when we go for treatment. In fact, at the root of all of this is a phenomenon called the Doppler effect. When a sound or light wave of a certain frequency is emitted from a source, a listener or viewer experiences a decrease or increase in that frequency if there is any relative motion between the source and the viewer. This change in frequency is measured to determine the speed of the source or listener. In astronomy, we hear about the Doppler shift based on this Doppler effect. The phenomenon was discovered or observed in 1842 by the 19th-century Austrian physicist **Christian Doppler**. It is named the Doppler effect after him. Physicist Doppler was born on November 29, 1803, in Salzburg, Austria. His contribution is still considered essential not only in physics, but also in various branches of medicine, astronomy, and technology. The 'Doppler Gun' has even become a great tool for law enforcement, helping them fine overspeeding drivers.



The name Halley's Comet is very familiar to all of us. And many of us probably also know that the relationship between this astrophysicist and mathematician, a contemporary of Sir Isaac Newton, has been fraught with tension. **Edmond Halley** was born in England on November 8, 1656, and published his first paper at the age of just twenty. In 1676, he left England, leaving his university studies unfinished, to travel to Saint Helena, an island in the South Atlantic Ocean, to observe the sky. The aim was to create a map of the stars in the southern hemisphere sky. He was encouraged in this regard by King Charles II of England himself and the Astronomer Royal, John Flamsteed, the highest authority on astronomy in England. In fact, Halley succeeded Flamsteed as his successor. Halley financed the publication of Newton's famous book Principia. Earlier, in 1682, Halley had ob-served and analyzed the orbit of Comet Halley, which played a significant role in Newton's law of universal gravitation. In fact, based on this, Halley made a prediction of the regular arrival of the comet. According to his calculations, the comet was expected to reappear in 1758, 76 years after 1682. His calculations were proven correct and the comet reappeared at exactly the right time in 1758. He had died before that in 1741. It was the first of the comets to be discovered to follow a regular orbit. In 1758, this comet was identified as Halley's Comet.



Canadian physician and scientist **Frederick Banting** shared the Nobel Prize in Physiology or Medicine with John Macleod in 1923. He was then only 32 years old and is still the youngest Nobel laureate in physiology or medicine. But more importantly, his research has benefited human civilization for the past hundred years, and his work occupies a unique place in the medical and social fields as a whole. Some of his contemporaries were able to show that insulin was necessary for the treatment of diabe-tes. Banting's main work was to isolate insulin from the pancreas of pigs, dogs, or cows and use it to treat diabetes. Banting was born on November 14, 1891. Behind his and MacLeod's Nobel Prizes, there are two other student and local researchers who contributed significantly. They were Charles Best and James Collip. Both Nobel laureates shared their prize money with their students; they also gave them other recognition. In the early days, the main source of insulin was material extracted from the pan-creas of dogs, pigs, or cows. Since the late 20th century, it has been possible to produce insulin artifi-cially, eliminating the need to take it from animals. However, it should be noted that when insulin was initially collected from dogs, it was done through animal sacrifice. Now, there is a huge ban on killing animals for research purposes. But we must not forget that it was through this seemingly abominable act that human civilization discovered not only diabetes but many other treatments.



It was only twenty-seven years of life. **Henry Gwyn Jeffrys Moseley** was born on November 23, 1887. He died in a direct battle on the battlefield of World War I, on August 10, 1915. It was later discovered that this scientist was nominated for the Nobel Prize in both Physics and Chemistry in 1915. This gives some indication of how fundamental and important the research contributions of Mosel were. Moseley attempted to determine the structure of the atomic nucleus of elements by analyzing the spectra of X-rays. At the Cavendish Laboratory, he was researching under Lord Ruth-erford, who had just discovered that there was a small region inside the atom where all the positive charge of the atom was stored. Mosel's research revealed that it is not the atomic weight, but the number of positive charges at the center of the atom that carries the true identity of the atom. Mosel's Law was discovered. Moseley's Law states that the square root of the frequency of an element's characteristic X-ray is directly proportional to the element's atomic number (Z), expressed by the formula $\sqrt{v} = a(Z - b)$, where v is the frequency, a is a universal constant related to the energy levels, and b is a screening constant accounting for inner electron shielding. This resulted in some changes in the periodic table of elements. His tragic death caused a stir in the scientific community of the time. The concerned authorities became aware. Later, it was recognized that it would be more productive to employ scientists in research laboratories to develop war-related innovations rather than sending them directly to the battlefield.

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