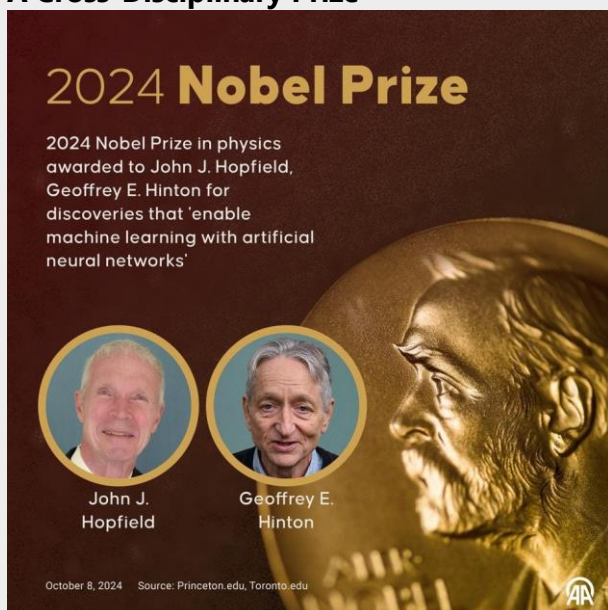


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1. The Neuropsychology and Physics Behind the 2024 Physics Nobel Prize

A Cross-Disciplinary Prize



The 2024 Physics Nobel Prize has sparked interest across disciplines due to its connection with neural networks. Many are puzzled, including physicists, as the citation does not clearly highlight the physics behind the award. Surprisingly, at the core of John Hopfield's Nobel-winning work lies not only fundamental physics but also a breakthrough discovery in neuropsychology, forming the basis for artificial neural networks (ANNs). These networks were later advanced by Geoffrey Hinton, another co-recipient, to power modern Artificial Intelligence (AI).

A Link to Cognitive Neuroscience

This year's prize also holds significance for cognitive neuroscientists. To understand its context, we must revisit the history of computational and neurological exploration. Early pioneers like David Hilbert, Kurt Gödel, Alan Turing, and Alonzo Church laid the groundwork for understanding computability in the 1930s and 1940s. Simultaneously, scientists were investigating how the brain computes.

The Hebbian Revolution in Learning and Memory

Progress on understanding the brain's learning mechanisms was slow until neuropsychologist Donald O. Hebb provided a crucial insight in 1949. Hebb discovered that synaptic connections between neurons change their effectiveness during learning in an irreversible manner, akin to plasticity. This foundational discovery advanced the study of learning and memory.

Hopfield's Breakthrough: The ANN Model

In 1982, physicist-turned-computer-scientist John Hopfield introduced a biologically plausible model for a neuronal network, inspired by the behavior of a fascinating physical system called a spin glass.

• What is a Spin Glass?

A spin glass forms when magnetic elements like iron or manganese mix with non-magnetic ones such as gold or copper. In this system, atomic spins freeze in random orientations, resulting in a vast number of energy-minimizing patterns.

• Mapping to Neurons

Hopfield analogized spins to neurons, which either fire or remain inactive, interacting and modifying their connections according to Hebb's principle. The energy-minimizing spin patterns correspond to memories in a neural network.

Associative Memory and the ANN Brain Model

Hopfield's ANN mimicked a biological brain where:

- Neurons fire or stay quiescent, influenced by electrical impulses.
- Memories are stored as patterns of synaptic changes.
- These patterns can be retrieved even from partial or distorted inputs.

This model marked a significant milestone, bridging physics and neuropsychology, and laying the groundwork for modern AI.

Advances and Diversification

Hopfield's work led to two major research directions:

1. **Improving ANN Architecture:** Focused on computational applications, fueling the AI revolution.
2. **Biological Realism:** Addressing cognitive and physiological aspects to make ANNs closer to biological systems.

This year's Physics Nobel not only honors transformative work in AI but also celebrates the interplay of physics, neuropsychology, and cognitive science.

Relevance: GS Prelims; Science & Technology

2. Sanganer Open Jail: A Unique Experiment in Prison Reform

Supreme Court Review of Sanganer Open Jail



The Sanganer open jail in Rajasthan is under scrutiny as a Supreme Court-appointed commissioner visits it to address a dispute over the Rajasthan government's plan to construct a hospital on part of its land. The inspection follows a contempt petition that claims the proposed construction could disrupt the jail's unique ecosystem.

What Are Open Prisons?

The Model Prisons and Correctional Services Act, 2023, defines open prisons as facilities where eligible prisoners are given more liberty compared to regular prisons, allowing them to engage in productive activities to ease their rehabilitation.

Key Features:

- Minimum security.
- Prisoners may work outside the prison, often in agriculture.
- Helps reduce overcrowding in traditional prisons.
- Facilitates reintegration into society post-release.

In some states, open prisons are standalone colonies where inmates can live with their families but have restricted movement.

History of Open Prisons in India

- The first open jail was set up in 1949 in Lucknow, Uttar Pradesh.
- Inspired by the Hague Conference of 1952, open-air camps allowed prisoners to lead near-community lives after completing part of their sentence.
- By the 1980s, India had 28-30 open jails, though only 13 states had formalized rules for them.
- These facilities often engage inmates in agriculture, dairy farming, or work on public projects.

Current Status

According to the Prison Statistics of India 2022:

- India has 91 open jails across 17 states.
- These jails can accommodate 6,043 inmates, with 4,473 prisoners currently lodged.
- Rajasthan has the highest number, with 41 open jails, followed by Maharashtra with 19.

What Makes Sanganer Open Jail Special?

A Pioneer in Open Prisons

- Established in 1963 as Sampurnanand Khula Bandi Shivar, it is named after a former Uttar Pradesh Chief Minister and Rajasthan Governor.
- Located 15 km from Jaipur, it houses 422 prisoners, including 14 women, along with their families.

Unique Features

1. Family Living:

- Inmates can stay with spouses and children.
- They build and renovate their homes using earnings from local jobs.

2. Self-Governance:

- Prisoners have their own bandi panchayats to ensure discipline and manage daily roll calls.

3. Community Integration:

- Inmates pay for water and electricity.
- They work in the local community, running grocery shops and other businesses.

4. Facilities:

- A primary school, anganwadis, and a playground.
- Access to phones for inmates.

5. Inmate Selection Criteria:

- Prisoners must have completed at least six years and eight months of their sentence.

Based on Sanganer's success, Rajasthan has developed 52 similar open-air camps, the highest in India.

The Dispute Before the Court

Land for Hospital Construction

The Jaipur Development Authority has allocated land for a hospital within the jail's premises. This decision has sparked opposition, with concerns that it might disrupt the functioning of the jail.

Legal Context

- The Supreme Court previously ruled that the area of open jails should not be reduced.
- A contempt petition by social worker Prasun Goswami claims that the hospital plan threatens the open jail's ecosystem.

Government's Position

- The state government denies plans to reduce the jail's area.
- It alleges that unauthorized structures were built by jail authorities.
- Promises have been made to allocate additional land and relocate inmates to new shelters.

Court's Observation

The Supreme Court bench emphasized balancing the needs of maintaining the open jail and building a hospital for local residents.

Conclusion

Sanganer open jail remains a unique model of prison reform, blending rehabilitation with community integration. However, the ongoing dispute underscores the challenges of balancing development with preserving innovative systems of justice.

Relevance: GS Prelims; Governance

3. Tamil Nadu Opposes Tungsten Mining in Madurai

What's the Issue?

The Central Government's decision to auction tungsten mining rights in Madurai's Nayakkarpatti block has sparked widespread opposition in Tamil Nadu. On December 9, 2024, the Tamil Nadu Assembly passed a unanimous resolution urging the Centre to revoke the mining rights, citing environmental, cultural, and federal concerns.

Strategic Importance of the Project

Centre's Perspective

- On November 7, 2024, the Union Ministry of Mines announced the auction of eight critical mineral blocks, including Nayakkarpatti in Madurai's Melur taluk.
- The Nayakkarpatti block, spanning over 2,015 hectares, is rich in scheelite, a primary tungsten ore essential for aerospace, defense, and green energy technologies.
- The auction aimed to bolster India's self-reliance in high-tech applications.

- Hindustan Zinc Limited, a Vedanta subsidiary, won the auction.



Opposition in Tamil Nadu

Ecological and Cultural Concerns

- The mining area overlaps with Arittapatti, a biodiversity-rich site with historical and cultural significance.
- Features: Cave temples, Jain symbols, Tamil Brahmi scripts, and rare species.
- Environmentalists fear mining waste, such as tailings, could release harmful heavy metals like arsenic, cadmium, and lead, contaminating soil and water.

Local Impact

- Villagers from Terkutteru, Muthuvelpatti, and

Kidaripatti fear environmental degradation and loss of livelihoods.

Vedanta's Track Record

- Opposition is amplified due to Vedanta's controversial history, including environmental violations at the Sterlite copper smelter in Thoothukudi.

Centre-State Tensions

Tamil Nadu's Objections

- The Tamil Nadu government claims it opposed the auction in October 2023 due to ecological and cultural concerns.
- Water Resources Minister Duraimurugan criticized the Centre for ignoring state objections, calling the move "condemnable."

State Assembly's Resolution

- The resolution urges the Centre to revoke the mining rights and seek state consent for such projects.
- Chief Minister M.K. Stalin vowed to block tungsten mining, stating, "If it comes, then I will not hold this post."

Centre's Response

- The Centre asserts that only 1.93 sq km of the 20.16 sq km block overlaps with the Arittapatti Biodiversity Heritage Site, notified by Tamil Nadu in 2022.
- It claims no formal objections were received during the auction process.

What's Next?

The Centre has yet to respond to the state's resolution, but protests continue in affected villages. The controversy underscores larger debates on federalism and the balance between resource management and environmental protection.

Relevance: GS Prelims; Governance