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Daily News Analysis

The Hindu Important News Articles & Editorial For UPSC CSE

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Page 06: GS 3 : Science & Technology

ISRO successfully conducted the second **short-duration hot test** of its **semicryogenic engine** at the **ISRO Propulsion Complex (IPRC), Mahendragiri** on **April 24, 2025**.

- This follows the **first successful hot test** conducted on **March 28, 2025**, marking significant milestones in India's advanced engine development programme.

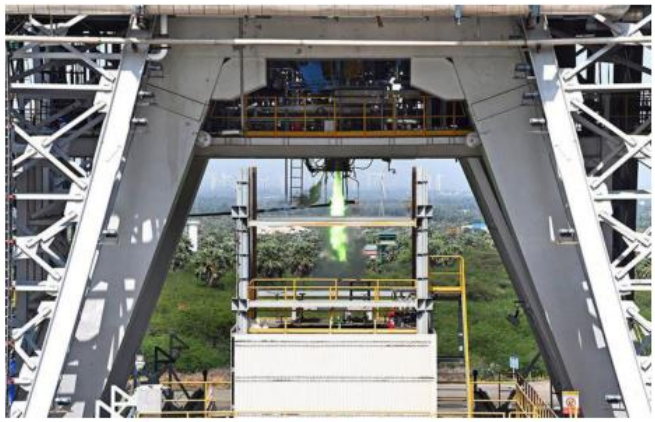
ISRO's second short hot test of semicryogenic engine a success

The Hindu Bureau
BENGALURU

The Indian Space Research Organisation (ISRO) has successfully conducted a short duration hot test of the semicryogenic engine at its facility in the ISRO Propulsion Complex (IPRC), Mahendragiri.

This ignition test, conducted on April 24, is the second milestone after the first successful hot test on March 28, which was a major breakthrough in the semicryogenic engine test programme.

In this test, the Engine Power Head Test Article, encompassing all engine systems except the thrust chamber, was subjected to a hot test for a duration of 3.5 seconds that validated the engine start-up sequence. During the test, the engine was successfully ignited and operated up to 60% of its rated power level, demonstrating stable and controlled performance.



Significant feat: This is the second milestone after the first successful hot test conducted on March 28. SPECIAL ARRANGEMENT

"These tests are part of a planned series of evaluations designed to validate the design integrity and performance of critical subsystems, including the low-pressure and high-pressure turbo pumps, pre-burner and associated control systems. The results provided crucial data to finalise the operational sequencing of the full semicryogenic engine," the ISRO said.

Further qualification tests are scheduled to comprehensively validate the engine system, ultimately paving the way for its induction into ISRO's launch vehicles.

Meanwhile, the launch campaign activities for NASA-ISRO Synthetic Aperture Radar (NISAR) satellite onboard the GSLV-F16 have already commenced in Sriharikota, the ISRO said.

The Second Stage (GS2) of the ISRO's GSLV launch vehicle was flagged off by V. Narayanan, Secretary, Department of Space, and Chairman, ISRO, on March 24, from the ISRO Propulsion Complex (IPRC), Mahendragiri, to the launch complex at Sriharikota.

"The Directors of ISRO Propulsion Complex (IPRC) and Vikram Sarabhai Space Centre (VSSC) also participated in the flag-off ceremony. This liquid stage is earmarked for the upcoming mission of GSLV (GSLV-F16), that will launch the NASA-ISRO Synthetic Aperture Radar (NISAR) satellite," ISRO said.

What is a Semicryogenic Engine?

Feature	Detail
Propellants	Uses liquid oxygen (LOX) as oxidizer and refined kerosene (RP-1) as fuel.
Combustion	Occurs at relatively lower temperatures compared to full cryogenic engines.
Efficiency	Provides higher thrust and specific impulse compared to conventional liquid engines.
Importance	Vital for enhancing the payload capacity of launch vehicles like GSLV and future heavy-lift missions.

Highlights of the Latest Test:

Test Description:

- Ignition test of the **Engine Power Head Test Article** (excluding the thrust chamber).
- Duration: **3.5 seconds**.
- Performance: Engine ignited successfully and operated at **up to 60% of rated power**.

Objectives Achieved:

- Validation of **engine start-up sequence**.
- Stable and controlled engine performance recorded.
- Critical subsystems such as **low-pressure and high-pressure turbo pumps, pre-burner, and control systems** successfully evaluated.

Future Steps:

- Additional qualification tests planned.
- Goal: Finalize operational sequencing and prepare for integration into **ISRO's upcoming launch vehicles**.

Strategic Importance for India:

- **Enhancing Launch Capabilities:**Semicryogenic engines will enable India to launch heavier payloads into different orbits (GTO, LEO, interplanetary missions).
- **Reducing Dependence:**Indigenous semicryogenic technology reduces dependency on foreign propulsion technologies.
    - Critical for India's aspirations to build **Next-Gen Heavy Lift Launch Vehicles**.
- **Cost Effectiveness:**Refined kerosene is cheaper than liquid hydrogen, making semicryogenic systems more economical.
- **Geopolitical Edge:**Strengthening India's position in the global commercial satellite launch market.

Parallel Developments: NISAR Mission

NISAR (NASA-ISRO Synthetic Aperture Radar):

- A collaborative Earth-observation mission between NASA and ISRO.
- Scheduled to be launched by **GSLV-F16** from Sriharikota.

Second Stage (GS2) Updates:

- GS2 liquid stage flagged off from IPRC Mahendragiri to the launch complex at Sriharikota on **March 24, 2025**.

Challenges Ahead:

- **Technical Complexity:**Semicryogenic engines demand precise engineering, especially in handling turbomachinery and start-up sequences.
- **Reliability Testing:**Extensive hot-fire and endurance testing are needed to ensure safe operationalization.
- **Integration with Current Launch Vehicles:**GSLV and future missions will require design optimizations for stage integration.
- **Global Competition:**Nations like the U.S., China, and Russia already have mature semicryogenic or kerolox propulsion systems.

Way Forward:

- **Accelerated Testing:** Speed up the full-scale combustor and engine testing phases.

- **Indigenization Drive:** Ensure full indigenous development of components like turbo pumps, injectors, and combustion chambers.
- **Application in Future Launch Vehicles:** Integrate into **Unified Modular Launch Vehicles (UMLV)** and future **Deep Space Missions**.
- **Strengthen Global Commercial Presence:**Showcase India's semicryogenic capacity to attract satellite launches globally.

UPSC Mains Practice Question

Ques : Discuss the significance of semicryogenic engine development for India's space ambitions. How does it contribute to self-reliance and competitiveness in the global space industry?

Rheumatology experts, speaking at a webinar under the "Healthy India, Happy India" initiative, emphasized that **early diagnosis and intervention** are crucial in arthritis treatment.

- They highlighted that **smoking** is a major **risk factor** for **rheumatoid arthritis** and stressed the need for **lifestyle changes**, **awareness**, and **comprehensive treatment approaches**.

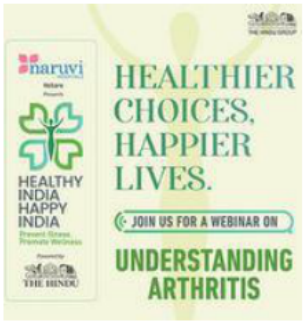
Smoking is a major risk factor for rheumatoid arthritis, say experts

The Hindu Bureau
CHENNAI

Emphasising that delayed diagnosis of arthritis can lead to permanent joint damage and deformities in individuals, senior rheumatologists on Sunday urged people to seek early intervention as it helps slow down its progress.

Speaking at a webinar on "Understanding arthritis", they pointed out that smoking is a strong risk factor for rheumatoid arthritis and advocated lifestyle changes, exercises, yoga, and a healthy diet that is low on carbohydrate and sugar but rich in fibre and protein.

The webinar was held as part of the ongoing "Healthy India, Happy India" initiative of Naruvi Hospitals, Vellore, in association with *The Hindu*. Sunday's edition was the



ninth in the series on the theme "Prevent Illness, Promote Wellness".

N. Raja, senior consultant in rheumatology, Naruvi Hospitals, Vellore, spoke on the importance of correct diagnosis of symptoms and timely treatment. He said arthritis was a grossly misunderstood clinical sign. "It does not denote a disease but is an inflammation of joints, including the knee, hip, wrist, shoulder, ankle, elbow and manifests as pain or swelling and stiffness that limits movements and affects daily activities," he explained, adding that the systemic condition could lead to eye inflammation, spinal fusion, and chronic deformities.

Throwing light on different types of arthritis - rheumatoid, psoriatic, osteoarthritis and gout - Dr. Raja said though often associated with ageing, it could affect any age group, and, therefore, it was important to avoid delay in treatment.

M.M. Kavitha, senior rheumatology consultant, Kauvery Hospital, Radial Road, Chennai, said awareness of arthritis was critical.

Dr. Kavitha said there was no single test to diagnose arthritis. A combination of clinical history, physical examination, blood investigations, and imaging such as X-ray, MRI, PET and bone scan help in confirming the diagnosis and monitoring disease progression.

S. Sham from Kauvery Hospital, Alwarpet, spoke about how treatment protocols had changed, and steroids and painkillers were not the main treatment for rheumatoid arthritis. "Disease-modifying agents entail different levels and combinations of drugs and take 8-12 weeks to start acting," Dr. Sham said.

The doctors reiterated the importance of patient education and reminded that once arthritis sets in, it cannot be cured but can go into remission with regular follow-up, comprehensive approach to treatment, including diet, exercise, and psychological support.

The webinar can be viewed at newsth.live/arthritis

What is Arthritis?

- **Definition:**Arthritis refers to **inflammation of joints** leading to pain, swelling, stiffness, and limited movement, impacting daily activities.
- **Types of Arthritis:**

Type	Characteristics
Rheumatoid Arthritis	Autoimmune disorder affecting joints and other organs.
Psoriatic Arthritis	Associated with psoriasis, affects joints and skin.
Osteoarthritis	Degeneration of joint cartilage, linked with aging.
Gout	Inflammatory arthritis due to uric acid crystal accumulation.

- **Complications:**If untreated, it can lead to **chronic deformities**, **spinal fusion**, and **systemic inflammations** (e.g., eye inflammation).

Major Risk Factors Identified:

- **Smoking:**
  - Strongly associated with the development and progression of rheumatoid arthritis.
  - Leads to enhanced immune system dysfunction and joint damage.
- **Poor Lifestyle Choices:**
  - Diets high in carbohydrates and sugar, lack of exercise.
- **Delayed Diagnosis:**
  - Misunderstanding arthritis as simply "aging pain" delays proper treatment.

Diagnosis Challenges:

No single definitive test for arthritis.Diagnosis is based on a combination of:

- **Clinical history and physical examination**
- **Blood investigations**
- **Imaging tools** like X-ray, MRI, PET scans, and bone scans.

Evolving Treatment Protocols:

Shift from **painkillers and steroids** to:

- **Disease-Modifying Anti-Rheumatic Drugs (DMARDs)**.
- Comprehensive therapy involving **medication**, **dietary control**, **exercise**, and **psychological support**.

Timeline:

- DMARDs usually require **8–12 weeks** to show effectiveness.

Key Message:

- Arthritis cannot be "cured" once fully developed but can enter **long-term remission** with continuous management.

Public Health and Policy Relevance:

- **Need for Awareness Campaigns:**Early signs recognition and risk factor awareness (especially regarding smoking) must be promoted under **National Health Mission (NHM)**.
- **Strengthening Primary Healthcare:**Equip PHCs and CHCs with facilities for early arthritis screening and basic rheumatology care.
- **Focus on Lifestyle Interventions:**Promotion of **yoga, balanced diets**, and **fitness programs** through initiatives like **Fit India Movement** and **Ayushman Bharat Wellness Centres**.
- **Patient Education:**Empower patients to manage chronic conditions through regular check-ups, physiotherapy, and mental health support.

Challenges Ahead:

- **Low awareness** among the general population, especially rural areas.
- **Limited access** to specialized rheumatology care.
- **High cost** of long-term arthritis medications and therapies.
- **Delayed health-seeking behavior** due to stigma or neglect.

Way Forward:

- **Strengthen Public Health Messaging:**Integrate arthritis awareness in broader anti-smoking and NCD (Non-Communicable Disease) campaigns.
- **Enhance Primary Care Training:**Train healthcare workers to identify early symptoms of arthritis.
- **Subsidize Chronic Disease Medications:**Make DMARDs and arthritis management affordable under government health schemes.
- **Promote Lifestyle Changes:**Encourage community-based yoga and fitness programs tailored for arthritis patients.
- **Research and Innovation:**Invest in indigenous research for affordable diagnostic tools and advanced therapies.

UPSC Mains Practice Question

Ques : Early diagnosis and comprehensive management of arthritis are crucial to prevent disability in India's aging and young populations alike. Discuss with reference to emerging public health strategies. **(250 Words)**

Page : 07 :GS 3 : Science & Technology and Agriculture

Scientists at **Martin Luther University, Germany**, have developed an **RNA-based antiviral agent** that offers **strong protection against Cucumber Mosaic Virus (CMV)** — a virus responsible for major crop losses globally and in India.

- This breakthrough could **revolutionize plant virus management** without the need for chemical pesticides or genetic modification.

RNA-based antiviral offers strong defence against deadly agri virus

According to the U.N. FAO, plant pests and diseases destroy nearly 40% of the world's annual crop. In India, CMV is responsible for 25-30% yield losses in banana plantations. In pumpkins, cucumbers, and melons, infection rates can soar up to 70%. Affected plants develop a mosaic discolouration, stunted growth, and commercially unviable fruits

Manjeera Gowravaram

Every year, farmers battle an invisible, relentless, formidable enemy: plant viruses. Unlike bacteria or fungi, which can be controlled with pesticides or fungicides, there is no straightforward way to cure crops of viral infections. According to the U.N. Food and Agriculture Organisation (FAO), plant pests and diseases destroy nearly 40% of the world's annual crop, costing the world more than $220 billion. Of that, plant viruses alone contribute to over $30 billion in losses each year.

In response, scientists started tapping the power of RNA-based technology to help plants defend themselves better – just the way our immune system fights off viruses. At Martin Luther University Halle-Wittenberg in Germany, a team of researchers recently reported developing an RNA-based antiviral agent that confers strong protection against cucumber mosaic virus (CMV), a widespread and destructive plant virus.

CMV infects more than 1,200 plant species, including critical food crops like cucumbers, squash, and cereals, and medicinal plants. It spreads through small sap-sucking insects called aphids. With nearly 90 aphid species capable of transmitting CMV, outbreaks are often difficult to contain.

In India, CMV is responsible for 25-30% yield losses in banana plantations. In pumpkins, cucumbers, and melons, infection rates can soar up to 70%. Affected plants develop a mosaic discolouration, stunted growth, and commercially unviable fruits.

HIGS and SIGS

In the new study, the researchers used RNA silencing, a natural defence mechanism found in plants. When a virus infects a plant, it introduces double-stranded RNA (dsRNA), which is a red flag for the plant's immune system.

The plant responds by activating Dicer-like enzymes (DCLs), which slice the dsRNA into small fragments called small interfering RNAs (siRNAs). These siRNAs then guide the plant's defence system to recognise and destroy the viral RNA, preventing the infection from spreading.

But this process is far from perfect. Not all siRNA generated by the plant are effective and the virus often mutates rapidly, evading the plant's natural defences. To strengthen plant immunity, researchers are exploring RNA-based crop protection techniques such as host-induced gene silencing (HIGS) and spray-induced gene silencing (SIGS).

HIGS works by genetically modifying plants to produce virus-fighting dsRNA in their own cells. This provides continuous protection throughout the plant's life. But regulations, high production costs, and the potential for viral resistance limit its widespread use.

Fighting challenge: CMV infects more than 1,200 plant species, including critical food crops like cucumbers, cereals, and medicinal plants. KELLY NEIL/UNSPLASH

SIGS is a more flexible alternative. Plants are treated with RNA sprays instead of being genetically modified. Leaves absorb the RNA, triggering the plant's natural immune response without altering its DNA.

While SIGS doesn't require genetic modification and is cost-effective and environmentally friendly, its effectiveness is limited: traditional dsRNA formulations produce a random mix of siRNAs, many of which fail to silence the virus efficiently.

To overcome the limitations of existing RNA-based approaches, the researchers developed a new approach that enhanced the effectiveness of RNA silencing against CMV.

Instead of using randomly generated dsRNA, they designed "effective dsRNA" – genetically engineered dsRNA enriched with highly functional siRNA. These specially selected siRNA bind to the virus's genetic material to trigger a stronger antiviral response. Their findings were published in *Nucleic Acids Research*.

In a laboratory setting, researchers first screened siRNA candidates and identified the most potent siRNAs against CMV. These e-siRNA were assembled into dsRNA constructs to ensure that when the plant's defence system processed them, they'd produce a high concentration of functional siRNA. This method resulted in a more targeted, more efficient form of RNA-based plant protection.

The researchers also tested their new method by applying the more-effective siRNA and dsRNA directly to a model plant, *Nicotiana benthamiana*, infected with CMV. They wrote in their paper that plants treated with this siRNA had almost 80% lower viral load, with some experiments achieving complete protection. The dsRNA formulation outperformed traditional dsRNA because the plant processed them into active siRNA more efficiently, creating a stronger immune response.

The team also found this method to be more effective against multiple CMV strains.

The new approach has three key advantages: (i) It's more precise because the plant's immune system is directed toward the viral particles' most vulnerable genetic regions, boosting its ability to fight infection. (ii) It provides a stronger defence because the more-effective dsRNA targets multiple regions of the viral genome simultaneously, making it harder for the virus to mutate and escape. (iii) The effective dsRNA can be redesigned in about a month to target new viral strains.

Researchers currently apply RNA-based agents manually in laboratory conditions either by injecting or by rubbing them onto plant leaves.

To make the treatment possible for real-world use, the team is currently developing spray-based solutions, and preparing for field trials to test their effectiveness in natural conditions.

While the study focused on CMV, the principles of the new dsRNA technology can be applied to combat other major plant viruses, such as the tomato yellow leaf curl virus, the potato virus Y, and the tobacco mosaic virus. The researchers have also expressed belief that RNA-based approaches can be extended to target fungal and bacterial diseases as well as insect pests.

More time

Despite its immense potential, one major hurdle is stability in outdoor conditions. RNA molecules degrade quickly when exposed to sunlight, rain, and soil microbes. The researchers are working on nanoparticle-based delivery systems to improve RNA stability and ensure long-lasting protection.

Another challenge is cost and scalability. While production costs are falling, large-scale use remains expensive. This requires further innovation that makes it economically viable for farmers.

Finally, regulatory approvals pose a challenge.

The U.S. Environmental Protection Agency granted the world's first approval for an RNA-based crop protection product only in 2023; the regulatory processes in other countries including India may take more time.

(Manjeera Gowravaram has a Ph.D. in RNA biochemistry and works as a freelance science writer. gmanjeera@gmail.com)

THE GIST

- In the new study, the researchers used RNA silencing, a natural defence mechanism found in plants. When a virus infects a plant, it introduces double-stranded RNA (dsRNA)
- Instead of using randomly generated dsRNA, they designed "effective dsRNA" – genetically engineered dsRNA enriched with highly functional siRNA
- To make the treatment possible for real-world use, the team is currently developing spray-based solutions, and preparing for field trials to test their effectiveness in natural conditions

Problem Statement:

Global Crop Losses:

- According to the **UN-FAO**, nearly **40% of global crops** are destroyed annually due to pests and diseases.
- Plant viruses alone cause over **$30 billion** in losses each year.

Specific Indian Context:

- CMV causes **25-30% yield loss** in banana plantations.
- Infection rates in pumpkins, cucumbers, and melons can reach up to **70%**.
- Affected plants exhibit **mosaic discoloration**, **stunted growth**, and **commercially non-viable fruits**.

Challenge with Plant Viruses:

- No direct cure exists unlike bacterial or fungal infections.
- CMV is transmitted by **~90 species of aphids**, making outbreaks difficult to control.

What is the New RNA-Based Solution?

Aspect	Details
Technology	RNA silencing using **engineered double-stranded RNA (dsRNA)**.
Mode of Action	dsRNA triggers the plant's natural immune response by producing **small interfering RNAs (siRNAs)** that destroy viral RNA.
Innovation	Creation of **"effective dsRNA"** enriched with **highly functional siRNAs** targeting multiple vulnerable regions of the virus.
Results	Up to **80% lower viral load**; some plants achieved **complete protection**.

Key Advantages of the New Approach:

- **Precision Targeting:**Directs plant immune response towards the virus's most vulnerable genetic sites.
- **Stronger Defence:**Simultaneously attacks multiple viral regions, making viral mutations difficult.
- **Flexibility:**New effective dsRNA can be **redesigned within a month** to tackle emerging viral strains.
- **Broader Application:**Could be extended to other viruses like **Tomato Yellow Leaf Curl Virus**, **Potato Virus Y**, **Tobacco Mosaic Virus**, and even to fungal and bacterial pathogens.

How RNA-Based Protection Methods Work:

Technique	Description	Pros	Cons
Host-Induced Gene Silencing (HIGS)	Genetically modifies plants to produce antiviral dsRNA.	Continuous protection	Regulatory and public acceptance issues.
Spray-Induced Gene Silencing (SIGS)	Spraying RNA externally onto plants.	No genetic modification, environmentally friendly	Traditional dsRNA sprays often inefficient.

This new method enhances SIGS efficiency by engineering highly functional siRNAs.

Challenges in Real-World Application:

RNA Stability Issues:

- RNA degrades rapidly due to sunlight, rain, and soil microbes.
- Solutions: Development of **nanoparticle-based delivery systems** to enhance stability.

Cost and Scalability:

- RNA production costs are still relatively high, limiting widespread agricultural use.

Regulatory Hurdles:

- First RNA-based crop protection was approved by the **U.S. EPA in 2023**.
- Countries like India may require **time-consuming regulatory clearance processes**.

Significance for India:

- **Agricultural Sustainability:**Reduces chemical pesticide dependence, promotes eco-friendly farming.
- **Food Security Enhancement:**Mitigates crop losses due to viruses, ensuring stable food supplies.
- **Boost to Agri-Biotech Innovation:**Encourages India's growing biotechnology and agritech startups sector.
- **Aligns with Missions like:**
    - *National Mission on Sustainable Agriculture (NMSA)*
    - *Atmanirbhar Bharat*in agricultural self-reliance.

Way Forward:

- **Accelerated Research and Field Trials:**Test RNA-based antivirals under diverse Indian agro-climatic conditions.
- **Develop Cost-Effective Production Systems:**Indigenous production of RNA sprays to make them affordable for small and marginal farmers.
- **Strengthen Regulatory Framework:**Fast-track approval mechanisms for innovative biocontrol solutions ensuring safety and efficacy.
- **Farmer Awareness Programs:**Educate farmers about RNA-based plant protection as part of integrated pest management (IPM).

UPSC MainsPractice Question

Ques :*Discuss the significance of RNA-based antiviral technologies in combating agricultural plant viruses. What challenges do they pose for large-scale adoption in India?*

Page 08 : GS 3 :Science and Technology

The International Monetary Fund (IMF) recently reported that while Artificial Intelligence (AI) expansion will significantly increase energy consumption, the economic benefits will likely outweigh the environmental costs.

- However, this assurance comes with a critical message - countries must integrate AI development with sustainable energy strategies. For India, which is building its AI infrastructure through initiatives like the IndiaAI Mission, it is crucial to proactively pursue green AI growth, aligning with the national goal of achieving net zero emissions by 2070.

Why AI Needs Sustainability Focus:

- AI data centres are set to consume massive amounts of electricity, comparable to major industries. In countries like the United States, AI expansion could increase electricity prices by up to 9%, indicating the scale of demand pressures.
- Renewable energy integration becomes vital to cushion against emissions that conventional energy sources would produce. Furthermore, AI infrastructure, particularly data centres, provides a unique opportunity because they can be coupled with captive renewable installations like solar plants.
- Nuclear energy, especially small modular reactors, could also play a role in powering AI hubs sustainably.
- Beyond electricity consumption, the AI ecosystem involves significant environmental impacts through large-scale mineral mining, water consumption, and electronic waste generation.
- Electronics manufacturing, a sector that India is promoting, must also adopt sustainable practices to manage this broader ecological footprint.
- Managing the environmental impacts of both AI growth and electronics manufacturing will be essential if India is to meet its ambitious climate commitments.

India's Opportunities and Strategic Imperatives:

- Sustainable AI development can help India project global leadership in green technologies while stimulating domestic innovation and economic growth.
- Building green AI infrastructure can drive job creation across renewable energy, technology, and electronics sectors. There is also scope for India to position itself as a destination for sustainable data centres, offering global firms clean energy-backed AI capacity.
- To ensure this, India must integrate renewable energy directly into AI infrastructure projects. Solar, wind, and emerging technologies like modular nuclear reactors could be linked with data clusters.

- Moreover, energy efficiency standards should be made mandatory for data centres, and green building certifications promoted. Carbon pricing, tax incentives, and green finance mechanisms can encourage private investment in clean AI technologies.
- Developing a research ecosystem focused on low-power AI hardware, energy-efficient algorithms, and eco-friendly manufacturing processes will further strengthen India's leadership in sustainable innovation.
- Public-private partnerships and global collaborations, especially under initiatives like the International Solar Alliance and Mission Innovation, can provide critical support.

Challenges:

- However, India faces significant challenges in realizing this vision. Renewable energy capacity, though growing, must expand rapidly to match the future demands of AI, manufacturing, and other industries.
- High initial investment costs for green infrastructure could deter adoption, particularly among small and medium players. Moreover, regulatory frameworks specifically focusing on sustainable AI development are still evolving.
- Access to critical minerals in an environmentally responsible manner remains a concern, given their importance for electronics and AI hardware.

Way Forward:

- India must adopt an integrated policy approach where AI development and climate action progress simultaneously. Promoting indigenous innovation in green technologies, strengthening green finance, and setting stringent environmental standards for new AI and data infrastructure will be critical.
- Focused investment in renewable energy-backed AI clusters in Tier-1 and emerging Tier-2 cities will also help balance economic growth with environmental responsibility. Additionally, aggressive efforts are needed to promote awareness among industries about the importance of sustainability in AI operations.

Conclusion:

The AI revolution offers India an opportunity not only to lead in emerging technologies but also to set a global example in sustainable innovation. By embedding clean energy practices into AI development from the outset, India can achieve economic growth without compromising its environmental goals, staying firmly on track toward its net-zero commitment by 2070.

UPSC Mains Practice Question

Ques :*"Artificial Intelligence offers transformative economic potential but could strain energy resources. Discuss how India can balance AI growth with its environmental commitments."Examine the challenges and opportunities for building a sustainable AI infrastructure in India.(250 words)*

In News : United Nations High Seas Treaty

Two years after countries adopted the high seas treaty, delegates recently gathered at the first session of the Preparatory Commission meeting in New York, to develop rules needed to implement the agreement and set the stage for the first Conference of Parties (COP1).

About UN High Seas Treaty

- The Biodiversity Beyond National Jurisdiction (BBNJ) Agreement , or the 'High Seas Treaty', is an international treaty under the United Nations Convention on the Law of the Sea (UNCLOS).
- It is the first-ever treaty to protect the world's oceans that lie outside national boundaries.
- It is also known as the 'Paris Agreement for the Ocean.'
- It is a legally binding treaty to protect marine life in international waters.
- It sets precise mechanisms for the sustainable use of marine biological diversity through international cooperation and coordination.
- It would also contribute to achieving several SDGs, particularly SDG14 (Life Below Water).
- The treaty will enter into force 120 days after the 60th country formally ratifies the agreement.

UN High Seas Treaty Features

- It contains 75 articles that aim at protecting, caring for, and ensuring the responsible use of the marine environment, maintaining the integrity of ocean ecosystems, and conserving the inherent value of marine biological diversity.
- It aims to place 30% of the seas into protected areas by 2030 (a pledge made by countries at the UN biodiversity conference in 2022).
- It will provide a legal framework for establishing vast marine protected areas (MPAs) to protect against the loss of wildlife and share out the genetic resources of the high seas.
- It also covers environmental assessments to evaluate the potential damage of commercial activities, such as deep-sea mining.
- It will establish a conference of the parties (CoP) that will meet periodically and enable member states to be held to account on issues such as governance and biodiversity.
- The treaty also includes a pledge by signatories to share ocean resources.
- Parties cannot claim or exercise sovereign rights over marine resources derived from the high seas and ensure fair and equitable sharing of benefits.
- It follows an inclusive, integrated, ecosystem-centric approach based on the precautionary principle and promotes using traditional knowledge and the best available scientific knowledge.
- It helps minimise impacts on the marine environment through area-based management tools and establishes rules for conducting environmental impact assessments.

What are High Seas?

- The high seas begin at the border of countries' exclusive economic zones, which extend up to 370 km (200 nautical miles) from coastlines.
- Beyond that point, the seas are under the jurisdiction of no country, and all countries have a right to fish, ship, and do research.
- They make up more than 60% of the world's oceans by surface area.
- Activities on the high seas are often unregulated and insufficiently monitored, leaving them vulnerable to exploitation.

Page : 08 Editorial Analysis

The real Indian arbitrator needs to stand up

Arun Chawla

is Director General, Indian Council of Arbitration

India's economic rise has, unsurprisingly, triggered many conversations about the potential of Indian arbitration as a significant contributor to the growth. An increase in domestic and cross-border commerce has made the occurrence of commercial disputes inevitable. The Indian court-litigation machinery remains overburdened and inadequately equipped to efficiently decide and dispose of these disputes, which are often time-sensitive, technical in nature, and entail large monetary sums. Resultantly, the mechanism of commercial arbitration, especially under the auspices of specialised arbitral institutions, becomes a popular solution. However the question that arises is this: is the Indian arbitration ecosystem living up to its perceived popularity? Is India truly on course to become a global hub of arbitration? While discussions routinely focus on legislative reforms or minimisation of judicial intervention, the most significant stakeholders of Indian arbitration, i.e., the arbitrators, escape scrutiny.

The subject of human capital

The success of any legal mechanism is defined not only by its theoretical framework but also by its human capital. For Indian arbitration, this human capital comprises the community of arbitration lawyers, but perhaps, more importantly, arbitrators who function as its decision-makers.

The credibility and the legitimacy of Indian arbitration is primarily defined by two parameters: first, the efficient conduct of arbitral proceedings, and second, the quality of arbitral awards. In both contexts, arbitrators literally play a decisive role. While arbitration lawyers are instrumental to the conduct of any proceeding, it is the arbitrators who have the power to dictate the arbitration's procedural framework, finalise timelines, determine procedural quibbles, and impose monetary sanctions in case either party's conduct is found lacking.

Likewise, it is their awards that can be challenged before a competent court in India or abroad. Thus, the Indian arbitrator is very much at the heart of the country's arbitration ecosystem.

Conversations about Indian arbitration rarely focus on the need to develop the elite Indian arbitrator

An exclusion

Nevertheless, conversations about Indian arbitration rarely focus on the need to develop the elite Indian arbitrator. While initiatives to augment the Indian arbitration bar are omnipresent, no similar enthusiasm exists in relation to the arbitration bench. This is unfortunate. In March 2024, the former Chief Justice of India, Justice D.Y. Chandrachud, had questioned why Indian arbitrators are not appointed in international disputes having no domestic element. His observation was not without basis. Barring the odd-exception, Indian arbitrators are absent from the informal community of repeatedly-appointed elite international arbitrators. What contributes to their exclusion?

The fundamental reason for the aforementioned paradigm is the identification of an elite Indian arbitrator with that of a retired Supreme Court or High Court judge. It is well-known that Indian courts prefer to appoint former judges as arbitrators, especially in high-value disputes. Over the years, this tendency has impacted the appointment practices of litigants, lawyers, and arbitral institutions. It is safely assumed that the judicial training and experience of a former judge will naturally translate into the efficient conduct of arbitral proceedings and higher quality of awards. However, as the Ministry of Finance's guidelines published in June 2024 show, the reality is vastly different. The Ministry painted a disappointing picture of lengthy and expensive arbitral proceedings that mimic court-procedures, resulting in poorly reasoned awards that are frequently challenged and set-aside.

Accordingly, the assumption that professionals with legal and judicial training do not require further capacity-building to become elite arbitrators requires correction. The judicial mind is a valuable asset, but is insufficient by itself in the realm of arbitration. A capable arbitrator wears several hats. He must not only be legally proficient but also a capable manager of the dispute resolution process who can blend procedural certainty with flexibility and innovation. This requires going beyond the rigid frameworks of civil procedure and evidentiary laws in India, and instead adopting global best-practices unique to international arbitration.

Arbitrators also often serve as part of a tribunal with members from diverse nationalities and cultures. Their internal deliberations, in which each arbitrator has to convince their colleagues of their viewpoint, are decisive. Engaging in these deliberations requires soft-skills whose existence cannot be taken for granted and often requires special training.

Finally, there are important differences between writing a judgment as an appellate judge of a common-law court and the drafting of an arbitral award. The second requires a meticulous examination of voluminous documentary evidence and testimonies of fact and expert witnesses, and intricate financial analysis to quantify any compensation or damages.

The improvements needed

Accordingly, the ecosystem of Indian arbitration requires at least two improvements. First, the pool of Indian arbitrators must be diversified to include candidates specialising in arbitration. The pool should not be restricted to advocates and retired judicial officers, but include trained experts from various fields who can bring a range of nuanced perspectives to decision-making. Second, each candidate, irrespective of their background, must undergo a rigorous training and accreditation process, such as through specialised certificate courses and workshops organised by arbitral institutions or membership of professional arbitration associations. The aim is to not only upskill but also create a culture in which arbitration is not perceived as a neglected-sibling of court-litigation. Only then could the real, elite Indian arbitrator rise to occupy their rightful place in the global arbitration community.

Paper 02:Indian Polity

UPSC Mains Practice Question:Critically analyze the role of human capital in strengthening India's arbitration ecosystem. Suggest reforms to enhance India's credibility as a global arbitration hub.(250 words)

Context :

- As India's economy grows and cross-border commercial activities increase, the need for efficient and credible dispute resolution mechanisms has become more urgent. Arbitration, as an alternative to traditional court litigation, has gained prominence.
- However, concerns are rising regarding whether the Indian arbitration ecosystem is living up to its potential, particularly focusing on the **quality and professionalism of Indian arbitrators**. The article critically examines the role and preparedness of Indian arbitrators in shaping India as a global arbitration hub.

Key Issues Highlighted:

- While discussions on arbitration reforms usually focus on minimizing judicial intervention or legislative amendments, the critical role of **arbitrators themselves** is often overlooked. The **human capital** — the arbitrators and arbitration lawyers — fundamentally determines the credibility of any arbitration system.
- Arbitrators are central to the efficient conduct of proceedings and the delivery of well-reasoned arbitral awards. Yet, India's current ecosystem heavily depends on **retired judges** from the Supreme Court and High Courts, assuming that judicial experience automatically translates into arbitration excellence. This assumption, as highlighted by recent observations including those by former Chief Justice D.Y. Chandrachud, has not resulted in the desired outcomes.

Challenges Identified:

- First, **over-reliance on retired judges** has shaped a system that often mimics traditional litigation. Arbitral proceedings become lengthy, expensive, rigid, and adversarial, losing the flexibility and efficiency that define successful arbitration.
- Second, **lack of specialised training** among arbitrators is a major concern. Judicial experience, while valuable, does not inherently equip individuals with the managerial skills, procedural adaptability, or international best practices necessary for effective arbitration.
- Third, **absence of global competitiveness** remains evident. Indian arbitrators are significantly underrepresented in international arbitration panels, reflecting a credibility gap at the global level.

- Fourth, **lack of focus on soft-skills** such as consensus-building, cultural sensitivity, and collaborative deliberations hampers the functioning of arbitration tribunals that often involve multinational members.
- Finally, differences in drafting arbitral awards versus traditional court judgments — especially in dealing with technical evidence, financial quantification, and expert testimonies — are inadequately addressed in the current arbitrator training processes.

Reforms Needed:

- The article advocates for **two major systemic reforms** to enhance India's arbitration ecosystem:
- First, the **diversification of the arbitrator pool** is essential. Apart from retired judges and senior advocates, the system must encourage subject-matter experts from engineering, finance, commerce, technology, and other fields to serve as arbitrators. This will introduce technical expertise, global perspectives, and improve the quality of awards in complex commercial disputes.
- Second, **mandatory training and accreditation** of arbitrators should be institutionalized. Arbitral institutions, law schools, and professional bodies must offer rigorous certification programs focused on international arbitration best practices, award drafting, procedural flexibility, and ethical standards.
- Creating a **professional culture** around arbitration, rather than treating it as a post-retirement career option, is crucial to achieving excellence.

Importance for India's Growth:

- A credible arbitration system is not just a legal requirement but an economic necessity. Efficient dispute resolution mechanisms foster a **business-friendly environment**, attract **foreign direct investment (FDI)**, and boost India's goal of becoming a **global commercial hub**.
- Moreover, in light of India's ambition to position itself as a **leading arbitration centre in Asia**, competing with Singapore and Hong Kong, it is imperative to strengthen both the **institutional infrastructure** and the **human capital** of arbitration.

Way Forward:

- India must institutionalize structured arbitrator training programs and promote merit-based appointments rather than defaulting to judicial seniority. Bar associations, arbitration councils,

and legal education institutions should collaborate to establish **clear accreditation pathways** for arbitrators.

- Additionally, the government must encourage international exposure, participation in global arbitration forums, and recognition of Indian arbitrators in global arbitration panels. A conscious cultural shift towards valuing arbitration as a distinct, specialized profession is necessary for India to truly emerge as a preferred arbitration destination.

Conclusion:

- If India is serious about its ambition of becoming a global arbitration hub, it must focus not just on legislative reforms but also on nurturing a pool of highly skilled, professionally trained, and globally competitive arbitrators. Only when the real, elite Indian arbitrator stands up, will Indian arbitration achieve both credibility and excellence on the world stage.
