

CRITICAL AND EMERGING TECHNOLOGIES INDEX

NEWS: A new global index, the Critical and Emerging Technologies Index, has been launched to assess the performance of **25 countries** across **five critical technology sectors: AI, biotechnology, semiconductors, space, and quantum.**

WHAT'S IN THE NEWS?

About the Critical and Emerging Technologies Index

- The **Critical and Emerging Technologies Index** is a **global ranking** developed by the **Harvard Kennedy School**.
- It evaluates **25 countries** based on their **performance in five strategically vital technology sectors**:
 - Artificial Intelligence (AI)
 - Biotechnology
 - Semiconductors
 - Space
 - Quantum Technology
- The goal of the index is to **provide insights to policymakers, researchers, and industry leaders** about a country's technological capabilities, risks, and opportunities in the global tech ecosystem.

Criteria for Evaluation

Each country is assessed in each technology sector using six core indicators:

- **Geopolitical Significance** – Impact on global power and diplomacy.
- **Systemic Leverage** – Role in influencing or shaping global technological systems.
- **GDP Contribution** – Extent to which the sector contributes to national output.
- **Dual-use Potential** – Civilian and defense applications of the technology.
- **Supply Chain Risk** – Dependence on foreign players for critical inputs or tools.
- **Time to Maturity** – Readiness of the technology for large-scale deployment.

India's Overall Position in the Index

- **India scored 15.2**, placing it **below France but above Russia, Canada, and Australia.**

- The report emphasizes that **India is significantly behind the U.S., China, and Europe** in most high-tech sectors.
- The gap is particularly evident in **semiconductors, AI, and quantum technologies**, where India lags in **funding, talent, and private R&D ecosystem**.

Performance of Other Countries

United States (U.S.)

- **Leads in all five sectors**, especially:
 - **AI**: Due to large investments, access to computing power and data, and a strong research community.
 - **Semiconductors**: Dominates chip design and manufacturing equipment.
 - **Space & Quantum**: Commands significant talent, funding, and defense applications.
- Its strength comes from a **decentralized innovation model** where government, academia, and private industry actively collaborate.

China

- **Rapid progress**, especially in:
 - **Biotechnology**: Major investments in genetic research and pharma.
 - **Quantum Technologies**: Strong public sector push and international partnerships.
- However, it still **relies heavily on foreign tools** and lacks **deep private sector innovation** in key sectors like AI and semiconductors.

Europe

- **Ranks third globally**, with particular strengths in:
 - **Biotechnology**: Strong pharmaceutical and research base.
 - **Quantum Technologies**: Advanced scientific capabilities and institutional support.
- However, Europe **lags behind in semiconductors and space**, largely due to **fragmented R&D efforts** and **less defense integration**.

Sector-Wise Summary

1. Artificial Intelligence (AI)

- **U.S. dominates** with leadership in:
 - Algorithms, data, computing infrastructure, and global talent.
- **China follows**, driven by aggressive state support and a growing AI ecosystem.
- **India is far behind** in funding, AI-specific computing infrastructure, and ecosystem maturity.

2. Biotechnology

- **U.S. and Europe lead** in:
 - Human capital, pharmaceutical innovation, and regulatory frameworks.
- **China is catching up**, particularly in vaccines, gene editing, and biologics.
- **India has strong pharma production** but lacks cutting-edge biotech R&D capacity.

3. Semiconductors

- **U.S. is the leader** in chip design and EDA tools.
- **Asia (Taiwan, Japan, South Korea)** is dominant in:
 - Manufacturing, fabrication (fabs), and packaging.
- **India lags** in design talent, foundry capabilities, and critical toolchains.

4. Space

- **U.S. is unmatched** in civil and military space investments and assets.
- **Russia retains some strategic legacy capabilities.**
- **India ranks 7th**, with achievements through ISRO, but underperforms in private sector and commercial satellite launches.

5. Quantum Technologies

- **U.S. leads** due to early investment in quantum hardware, algorithms, and security.
- **China is advancing quickly**, but mostly in state-driven projects.
- **Europe shows scientific strength**, though commercialization is limited.
- **India is in early stages**, supported by initiatives like the **National Quantum Mission (NQM)**.

Key Takeaways for India

- India's relatively low ranking reflects:

- **Underinvestment in frontier R&D,**
 - **Shortage of specialized human capital, and**
 - **Limited coordination between academia, industry, and government.**
- Despite strengths in pharmaceuticals and digital public infrastructure, **India's long-term technological competitiveness remains fragile** without reforms.

Way Forward for India

- **Increase Strategic Investment:** India must invest more in R&D, especially in semiconductors, AI, and quantum tech.
- **Focus on Talent Development:** Building a high-skill STEM workforce and attracting global talent is key.
- **Promote Public–Private Collaboration:** Encourage innovation hubs and link universities with industry to accelerate breakthroughs.
- **Support Indigenous Capabilities:** Reduce dependency on foreign tech in critical areas through Make-in-India initiatives.
- **Leverage Digital Public Infrastructure (DPI):** Use platforms like UPI, Aadhaar, and ONDC as springboards to foster deep tech innovation.

Source: <https://www.thehindu.com/data/india-trails-in-critical-tech-particularly-semiconductor-tech/article69732240.ece>