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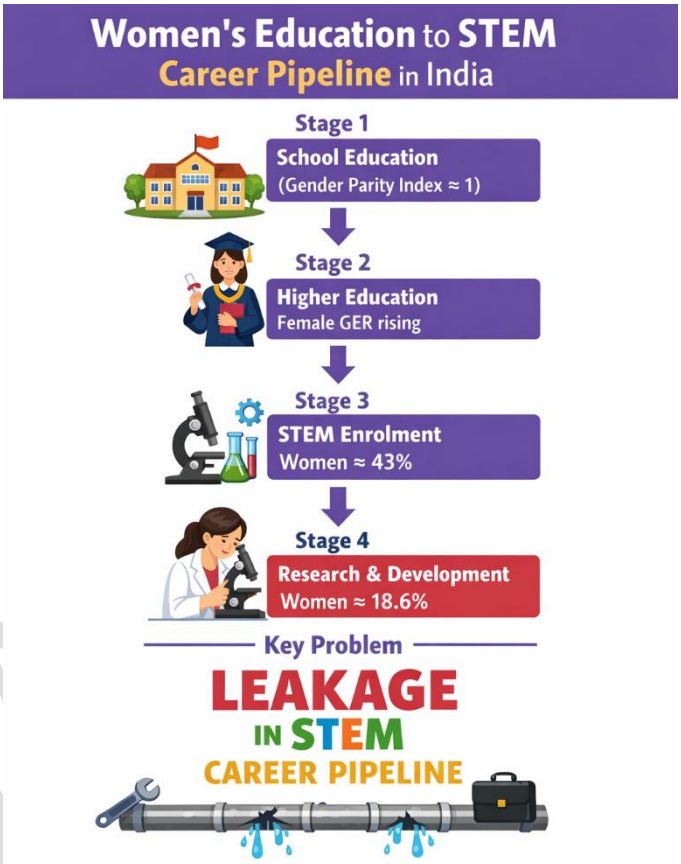
GS Paper I: Society

1. Women in STEM and the Knowledge Economy: Realising the Power of Nari Shakti

a. Introduction



The global economy is undergoing a profound transformation in which knowledge, innovation and technology have become the primary drivers of economic growth. In this emerging system—often described as the knowledge economy—economic progress depends less on natural resources and more on the ability of societies to generate ideas, conduct research and develop advanced technologies.

Fields such as artificial intelligence, biotechnology, data science, robotics and digital technologies increasingly determine economic competitiveness and strategic strength. Within this context, women's participation in education, science and research becomes critically important. When women actively contribute to science and technology, they expand the intellectual capacity of society, accelerate innovation and promote inclusive economic growth.

India has gradually acknowledged this transformation in its policy discourse. The emphasis has shifted from the earlier notion of "women's development" toward the broader vision of "women-led development." In this framework, women are viewed not merely as beneficiaries of welfare policies but as active creators of knowledge, innovation and national progress.

b. Understanding STEM and Its Importance

i. Meaning of STEM

The term STEM refers to four major domains of knowledge that form the foundation of modern scientific and technological progress.

- Science involves systematic investigation and the discovery of natural laws governing the physical and biological world.
- Technology refers to the practical application of scientific knowledge to develop tools, digital systems and technological platforms.
- Engineering focuses on designing and constructing infrastructure, machines and complex technological systems.
- Mathematics provides the logical and quantitative framework that supports scientific analysis, modelling and technological innovation.

Together, these disciplines constitute the core intellectual infrastructure of the knowledge economy.

ii. Why STEM is Crucial for National Development

STEM capabilities are central to national development for several reasons.

- STEM research drives scientific discovery and technological innovation, which are essential for addressing global challenges such as climate change, public health crises and energy transitions.
- STEM sectors support industrial transformation, particularly in advanced manufacturing, biotechnology, space technology and digital services.
- These fields generate high-skilled employment opportunities, enabling countries to build a technologically capable workforce.
- Nations with strong STEM capabilities achieve greater technological sovereignty and economic competitiveness in the global economy.

Recognising the importance of STEM, India has made significant progress in expanding educational opportunities for girls and women, particularly at the school level.

c. Expansion of Women's Education in India

i. Achieving Gender Parity in School Education

One of the most significant social transformations in India has been the rapid expansion of girls' access to education. Over the past two decades, government initiatives and social awareness campaigns have substantially increased female participation in schools.

- India has nearly achieved gender parity in school enrolment.
- The Gender Parity Index, which measures the ratio of girls to boys enrolled in education, has reached approximately one at the foundational and middle school levels.
- At the secondary stage, the index is slightly above one, indicating that girls' participation is now equal to or marginally higher than that of boys.

These developments represent a major step toward educational equality and social empowerment.

ii. Reduction in Dropout Rates

Alongside improved enrolment, the dropout rate among girls has declined significantly.

- Improved school infrastructure and scholarship schemes have encouraged families to continue girls' education.
- Welfare initiatives and awareness campaigns have highlighted the importance of educating girls.
- As a result, more girls are now completing secondary education, strengthening the pipeline for higher education and professional careers.

With stronger foundations at the school level, increasing numbers of women are now entering higher education institutions across the country.

d. Expansion of Higher Education and Women's Participation

India's higher education sector has expanded significantly over the past decade, both in terms of institutional capacity and student enrolment.

- Total student enrolment has increased from approximately 3.42 crore to more than 4.46 crore.
- Female enrolment has risen from about 1.57 crore to over 2.18 crore.
- The Female Gross Enrolment Ratio (GER) in higher education has improved from around 22.9 to more than 30.

These developments indicate that women are increasingly entering universities and colleges, thereby strengthening India's human capital base.

Within this expanding higher education landscape, women's participation in STEM disciplines has shown particularly encouraging progress.

e. Women's Participation in STEM Education

India has witnessed notable improvements in women's participation in STEM education.

- Women now constitute approximately 43 percent of total STEM enrolment in higher education, one of the highest proportions globally.
- This marks a significant shift from earlier decades when science and engineering education was largely dominated by men.
- Increasing numbers of women are now pursuing careers in engineering, computer science, biotechnology and data science.

The rising presence of women in STEM education is important not only for gender equality but also for expanding the country's scientific talent pool.

However, despite these achievements in education, women remain underrepresented in research and development careers, indicating the presence of a structural gap between education and professional research pathways.

f. Women in Research and Development

i. Current Participation Levels

Despite rising STEM enrolment, women constitute only around 18.6 percent of India's research and development workforce.

- Many women who complete STEM degrees do not continue into long-term research careers.
- Structural barriers and career interruptions often contribute to this transition gap.

ii. Growth in Advanced Education

Encouraging trends are nevertheless visible in postgraduate and doctoral education.

- Postgraduate enrolment has expanded significantly in recent years.
- Doctoral enrolment has increased from roughly 47,000 to more than 1.12 lakh students.
- Increasing numbers of women are entering advanced research programmes, which may gradually raise female participation in research ecosystems.

Women researchers are distributed across multiple institutional sectors within India's scientific landscape.

g. Sectoral Distribution of Women Researchers

Women researchers in India are present across government laboratories, universities and industrial research establishments.

- Government research institutions account for nearly 46 percent of women researchers.
- Universities and higher education institutions employ around 28 percent.
- The industrial research sector accounts for roughly 26 percent.

This distribution suggests that while women are relatively well represented in public research institutions, their participation remains lower in private sector research and technology industries.

Addressing this imbalance requires targeted policies and institutional support mechanisms.

h. Government Initiatives Supporting Women in STEM

i. Encouraging Early Technological Exposure

- Atal Tinkering Laboratories established in schools encourage students to experiment with robotics, artificial intelligence and coding.
- These initiatives allow girls to develop confidence and interest in technology from an early age.

ii. Increasing Representation in Engineering Institutions

- Supernumerary seats for women have been introduced in the Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs).
- As a result, women's representation in these institutions has increased from less than 10 percent earlier to more than 20 percent today.

iii. Supporting Research Careers

- The Prime Minister's Research Fellowship (PMRF) provides financial and academic support for advanced research in science and technology.
- The UGC Junior Research Fellowship (JRF) programme has witnessed increasing female participation, with women constituting more than half of fellowship recipients in STEM fields.

iv. Strengthening the National Research Ecosystem

- The establishment of the Anusandhan National Research Foundation represents a major institutional reform aimed at strengthening India's research ecosystem and fostering collaboration between academia and industry.

v. Infrastructure and Safety Measures

- Policy initiatives have also emphasised the creation of safe and affordable hostel facilities for girls across districts, enabling women from diverse social backgrounds to pursue higher education.

The combined impact of these initiatives contributes to the growing role of women in the knowledge economy.

i. Significance of Women's Participation in the Knowledge Economy

i. Strengthening Innovation

- Diverse research communities generate more creative and comprehensive scientific solutions.
- Women scientists bring new perspectives and research questions, enhancing innovation.

ii. Accelerating Economic Growth

- Knowledge-based industries require highly skilled professionals.
- Women's participation increases the size and diversity of the skilled workforce.

iii. Promoting Social Empowerment

- STEM careers provide women with financial independence and professional recognition.
- This contributes to broader social transformation and gender equality.

iv. Advancing Inclusive Development

- Active participation of women in high-growth sectors ensures that economic development becomes more inclusive and equitable.

v. Supporting the Vision of Viksit Bharat

- India's aspiration to become a developed nation by 2047 depends on strengthening its knowledge base and technological capabilities, in which women's participation will be indispensable.

Despite this progress, several structural barriers continue to limit women's full participation in STEM.

j. Challenges in Women's STEM Participation

- Women remain underrepresented in senior leadership positions within research institutions and scientific organisations.
- Career interruptions related to family responsibilities and maternity can affect long-term research trajectories.
- Participation of women in technology industries and private sector research remains relatively low.
- Persistent social stereotypes regarding gender roles may discourage girls from pursuing scientific careers.

Addressing these barriers is essential for achieving genuine gender equality in scientific fields.

k. Way Forward

A comprehensive strategy is necessary to strengthen women's participation in India's knowledge economy.

- Educational policies should continue to encourage girls' participation in science and mathematics at the school level.
- Mentorship networks and professional support systems can help women navigate research careers and leadership pathways.
- Technology companies should adopt gender-inclusive hiring practices and supportive workplace policies.
- Universities and research institutions should implement work–life balance measures to support long-term scientific careers.
- Expanding scholarships, fellowships and infrastructure support will enable women from diverse backgrounds to pursue advanced STEM education.

Conclusion

Women are increasingly emerging as a transformative force within India's knowledge economy. Their growing participation in education, scientific research and emerging technologies is reshaping the country's innovation landscape.

By ensuring equal opportunities, supportive institutions and inclusive policies, India can fully harness the potential of Nari Shakti. In doing so, women will not only contribute to scientific advancement but will also become central architects of a knowledge-driven and developed India in the decades ahead.

GS Paper I: Society

2. Fiscal Autonomy of Cities in India: Finance Commission Grants and Urban Governance

a. Introduction

Urbanisation has emerged as one of the most significant structural transformations in contemporary India. Cities today function as engines of economic growth, generating nearly two-thirds of the

country's gross domestic product and serving as centres of employment, services and innovation. At the same time, India's urban population is expected to reach around 600 million by 2030, placing immense pressure on urban infrastructure, housing, mobility systems, water supply and climate resilience.

Despite their central role in economic development, Indian cities face a fundamental constraint: limited fiscal autonomy. Urban Local Bodies (ULBs) rely heavily on transfers from Union and State governments, while their own revenue bases remain underdeveloped. Even grants recommended by the Finance Commission, which are intended to strengthen local governments, constitute only a modest share of the economy and are often accompanied by strict conditions.

Thus, the question of municipal finance is not merely technical; it lies at the heart of the broader challenge of urban governance, decentralisation and democratic capacity in India.

b. Constitutional Framework of Urban Local Governance

Institutionalisation through the Seventy-Fourth Constitutional Amendment

Urban local governance in India was significantly strengthened by the Seventy-Fourth Constitutional Amendment Act, 1992. This reform sought to deepen democratic decentralisation by recognising municipalities as institutions of self-government.

- The amendment inserted the Twelfth Schedule into the Constitution, listing 18 functions assigned to municipalities.
- These functions include urban planning, regulation of land use, water supply, sanitation, roads, public health, urban forestry and slum improvement.
- It also mandated the creation of State Finance Commissions (SFCs) to recommend the distribution of financial resources between State governments and local bodies.
- At the national level, Article 280 requires the Finance Commission to recommend grants from central tax revenues for strengthening local governments, including municipalities.

However, the constitutional promise of self-government has not translated fully into financial independence. Municipalities continue to function with limited fiscal powers and heavy dependence on higher tiers of government.

c. Revenue Sources of Urban Local Bodies

Municipal finances in India generally depend on three major categories of revenue.

i. Own Source Revenue

Own Source Revenue refers to the funds that municipalities generate directly through taxation and service charges.

- Major sources include property tax, user charges for water supply and waste collection, parking fees, trade licences and municipal levies.
- Among these, property tax remains the most important and stable source of municipal revenue across the world.
- In India, however, property tax collections remain weak because of poor assessment systems, outdated property records and political reluctance to revise tax rates.

ii. Transfers from State Governments

State governments provide financial assistance to municipalities through grants and by sharing certain taxes.

- These transfers vary significantly across States.
- As a result, there are wide disparities in the financial capacity of municipalities across India.

iii. Central Transfers through the Finance Commission

The Finance Commission recommends grants to local governments in order to strengthen the provision of civic services.

- These transfers are especially important for municipalities with limited tax bases and weak administrative capacity.
- However, central transfers alone cannot substitute for robust local revenue systems.

The importance of Finance Commission transfers is clear, but their actual scale remains far smaller than what the expanding urban economy requires.

d. Scale of Finance Commission Grants to Cities

Although Finance Commission grants have increased in absolute terms over time, their size relative to the national economy remains modest.

i. Grants under the Fifteenth Finance Commission

Under the Fifteenth Finance Commission, Urban Local Bodies received approximately ₹1.2 to ₹1.3 lakh crore over a five-year period.

- During the same period, India's GDP stood at roughly ₹200 to ₹210 lakh crore.
- Consequently, total transfers to cities amounted to only about 0.12 to 0.13 percent of GDP.

ii. Expected Grants under the Sixteenth Finance Commission

The Sixteenth Finance Commission is expected to recommend around ₹3.56 lakh crore for Urban Local Bodies between 2026 and 2031.

- However, India's GDP during this period may approach ₹400 lakh crore.
- Therefore, the share of such transfers is likely to remain at about 0.13 percent of GDP.

This indicates that while nominal allocations are increasing, the relative fiscal commitment to cities remains limited. There is therefore a clear mismatch between the economic importance of cities and the public resources transferred to them.

The challenge is compounded by the design of these grants, many of which are not fully flexible.

e. Nature of Finance Commission Grants: Tied and Performance-Based Transfers

A major feature of Finance Commission transfers is that a substantial proportion is accompanied by conditions and usage restrictions.

i. Meaning and Implications of Tied Grants

Tied grants are funds that must be spent only on specific sectors or activities.

- In urban governance, these usually relate to water supply, sanitation, wastewater treatment and solid waste management.
- These sectors are undoubtedly important for public health and environmental sustainability.
- However, tied grants reduce the fiscal flexibility of municipalities.

For example, a city facing urgent issues such as urban flooding, traffic congestion, air pollution or housing shortages may not be able to divert tied grants toward those priorities. As a result, local governments may remain unable to respond to their own context-specific developmental needs.

ii. Performance-Based Grants

Another component of Finance Commission transfers consists of performance-linked incentives.

- Municipalities may need to meet conditions such as regular elections, audited accounts, fiscal discipline and the functioning of State Finance Commissions.
- These provisions are intended to strengthen accountability, transparency and governance standards.
- However, municipalities that fail to meet these benchmarks may lose access to much-needed grants, thereby worsening their financial vulnerability.

Thus, while conditionalities are designed to improve governance, they can also deepen inequalities between relatively strong and weak municipalities.

f. Emphasis on Own Source Revenue

Finance Commission recommendations have increasingly emphasised the need to improve municipal revenue generation.

- Cities are encouraged to expand property tax collections, rationalise user charges and improve administrative capacity for revenue collection.
- Some recommendations suggest that municipalities should aim to generate about ₹1,200 per household through local revenues.
- This emphasis is grounded in the idea that fiscal sustainability requires stronger local taxation.

However, many municipalities struggle to achieve these goals because of:

- Outdated property records
- Weak valuation systems
- Poor tax administration
- Political resistance to raising taxes and service charges

Therefore, strengthening own source revenue is necessary, but it cannot happen without broader institutional reforms.

g. Federal Dimensions of Urban Financing

Urban finance raises important questions related to fiscal federalism and intergovernmental relations.

i. Urban Development as a State Responsibility

Under the constitutional scheme, urban development is placed in the State List.

- This means States have primary responsibility for structuring and supervising urban governance.
- Therefore, strong conditionalities imposed by the Union on urban grants may sometimes be viewed as encroachments upon State autonomy.

ii. Incentives for Urban Expansion

Some policy proposals have suggested providing financial incentives for the merger of peri-urban villages into urban jurisdictions.

- Such measures may help in planned urban expansion.
- However, they can also generate administrative complications and may weaken rural local bodies.

iii. Growing Role of Cesses and Surcharges

A deeper structural issue is the increasing use of cesses and surcharges by the Union government.

- These revenues do not form part of the divisible pool shared with States.
- Such collections are estimated at around 2.2 percent of GDP, representing a substantial amount of public revenue.
- Much of the economic activity that generates these revenues originates in urban areas, yet municipalities receive no direct share.

This trend weakens both fiscal federalism and the resource capacity of local governments.

The weakness of urban finances is also rooted in broader structural constraints that go beyond formal grant design.

h. Structural Challenges in Urban Finance

Several deeper structural problems continue to constrain the financial capacity of Indian cities.

i. Declining Per Capita Transfers

As the urban population expands, available resources are spread across a larger number of residents.

- This leads to declining per capita transfers.
- Consequently, cities find it harder to invest adequately in infrastructure and public services.

ii. Weak Administrative Capacity

Many municipalities lack sufficient technical and managerial expertise.

- Deficiencies are visible in financial management, urban planning, project formulation and execution.
- These weaknesses often lead to delays in implementation and underutilisation of available funds.

iii. Limited Attention to Climate Resilience

Urban areas face growing climate risks such as floods, heat waves and water scarcity.

- Yet the current fiscal system does not provide adequate dedicated financing for urban climate adaptation and resilience.
- This makes Indian cities more vulnerable to future environmental stresses.

These structural limitations show that the problem is not merely one of quantum of funds, but also of governance capacity and fiscal design.

For this reason, fiscal autonomy must be seen as a core requirement for effective urban governance.

i. Importance of Fiscal Autonomy for Cities

Fiscal autonomy is essential for meaningful urban self-government.

- Cities need adequate and predictable financial resources to undertake long-term infrastructure planning.

- They must be able to maintain public services and respond to changing challenges such as migration, environmental stress, technological change and social inequality.
- Without financial independence, municipalities remain dependent on higher levels of government and cannot implement locally responsive development strategies.

In other words, political decentralisation without fiscal empowerment produces only partial self-government.

This makes the case for reforms that can strengthen both the revenue base and the institutional capacity of Urban Local Bodies.

j. Way Forward

A comprehensive reform strategy is necessary to strengthen the fiscal autonomy of Indian cities.

i. Strengthening Municipal Revenue Systems

- Property tax administration should be modernised through digital mapping, GIS-based records and improved valuation systems.
- User charges should be rationalised in a manner that improves cost recovery without undermining affordability.

ii. Expanding Fiscal Decentralisation

- Both Union and State governments should provide cities with more predictable and adequate transfers.
- Greater decentralisation is necessary to align fiscal powers with functional responsibilities.

iii. Increasing Untied Transfers

- A larger proportion of Finance Commission grants should be provided as untied grants.
- This would allow municipalities to allocate resources according to local priorities and context-specific needs.

iv. Reforming the Cess and Surcharge Structure

- Bringing a greater share of revenues into the divisible pool would strengthen fiscal federalism.
- This would indirectly improve the resource position of States and, through them, of local governments.

v. Building Municipal Capacity

- Sustained investment is needed in municipal administration, financial management systems and urban planning institutions.
- Stronger institutions will enable cities not only to receive funds but also to utilise them effectively.

A more empowered and capable municipal system is indispensable for managing India's rapid urban transition.

Conclusion

Cities occupy a central position in India's economic transformation and urban transition. Yet the financial resources available to Urban Local Bodies remain limited, fragmented and often constrained by tied grants and conditional transfers. The result is a persistent gap between the functions assigned to municipalities and the fiscal powers available to them.

For India to manage rapid urbanisation successfully, it must strengthen the fiscal autonomy, revenue capacity and governance capability of its cities. Empowering municipalities with adequate resources, greater flexibility and stronger institutions will be essential for building sustainable, resilient and inclusive urban development in the decades ahead.

GS Paper II: Current Affairs

3. Women in STEM in India: Understanding the "Leaky Pipeline"

a. Introduction

Scientific knowledge and technological capability form the backbone of modern economic development. Nations that build strong systems of research, innovation and technological advancement are better positioned to compete in the global knowledge economy. In this context, the participation of women in Science, Technology, Engineering and Mathematics (STEM) has become an important subject of public policy and academic analysis.

Across the world, women remain significantly underrepresented in scientific careers despite constituting nearly half of the global population. One of the most widely used concepts to explain this pattern is the idea of the "leaky pipeline." The term refers to the gradual reduction in the number of women at successive stages of scientific education and professional advancement.

India presents an especially important variation of this global pattern. Unlike many countries where girls are underrepresented in STEM education itself, India produces one of the largest proportions of female STEM graduates in the world. Yet women remain significantly underrepresented in research careers, faculty positions and scientific leadership. This shows that in India, the major leakage in the pipeline occurs after formal education, especially during the transition from academic training to long-term research careers.

b. The Concept of the Leaky Pipeline

The idea of the leaky pipeline describes the progressive decline in women's participation across successive stages of scientific education and professional advancement.

A typical STEM career pathway involves several stages:

- School education, where interest in science subjects is formed
- Undergraduate training in science or engineering disciplines
- Postgraduate and doctoral education
- Entry into research, academic or industrial scientific employment
- Progression into senior positions and scientific leadership

At each stage of this progression, a proportion of women exit the system. Over time, this cumulative attrition results in a much smaller number of women occupying senior scientific positions. The pipeline therefore appears to "leak" as women move along the career trajectory.

c. Global Pattern of the Leaky Pipeline

In many parts of the world, the decline in women's participation begins very early in the educational system.

i. Early Gender Stereotyping

- Social stereotypes often portray mathematics, physics and engineering as male-dominated fields.
- Girls may therefore be discouraged from pursuing advanced scientific subjects during school education.
- This early discouragement later translates into lower participation in science and engineering degrees at the university level.

ii. Declining Representation Across Stages

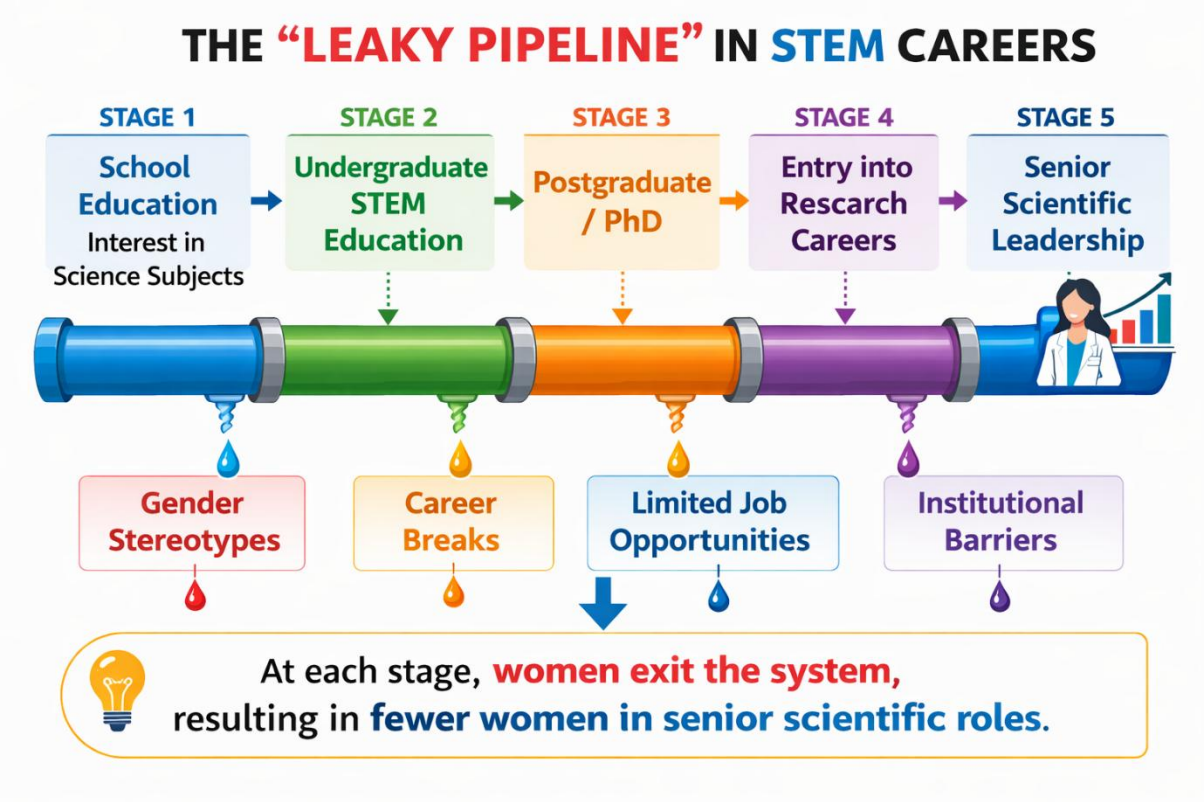
Global statistics illustrate this pattern clearly.

- Women account for roughly 35 percent of STEM graduates worldwide.

- Their representation changes at advanced levels, with women earning about 40 percent of STEM doctoral degrees in some contexts.
- In the global scientific workforce, however, women constitute only around 30 percent of researchers.

Thus, in many countries, the leakage begins from the stage of school education onward and continues throughout the professional journey.

India, however, differs in a significant respect: the early educational part of the pipeline is comparatively much stronger.



d. India's Distinct Pattern

India does not follow the same pattern as many other countries because the gender gap in STEM education is relatively narrower.

i. Strong Participation in Science Education

Girls in India increasingly pursue science subjects during secondary and higher education.

- In several regions, the proportion of girls enrolling in the science stream after Class X reaches around 60 percent.
- At the higher secondary and undergraduate levels, women form a substantial share of science students.
- Women represent around 43 percent of STEM graduates in higher education, placing India among countries with the highest female participation in STEM education.

ii. Strength at Advanced Educational Levels

India's relative strength is visible not only at the undergraduate stage but also at higher levels.

- Women form a significant share of students in postgraduate and doctoral education across many scientific disciplines.
- This indicates that the educational segment of the pipeline remains relatively robust.
- In other words, many women successfully enter and complete STEM education.

This creates an important analytical question: if women are entering and completing STEM education in large numbers, why are they not equally visible in research institutions and leadership roles?

The answer lies in the major point of attrition that appears after education.

e. The Major Leak in India's STEM Pipeline

Despite strong participation in education, women remain significantly underrepresented in long-term research careers and scientific institutions.

i. Underrepresentation in the Research Workforce

- Women constitute only around 18 percent of India's research and development workforce.
- This figure is far lower than their share in STEM education.
- The contrast reveals a sharp attrition between educational achievement and professional scientific employment.

ii. Underrepresentation in Scientific Institutions

The gap becomes more visible in major institutions.

- Women constitute roughly 29 percent of scientists in the Indian Council of Medical Research (ICMR).
- Their representation in the Defence Research and Development Organisation (DRDO) is around 14 percent.
- In premier institutions such as the Indian Institutes of Technology (IITs), women faculty members account for only around 11–13 percent.
- In some elite institutions, such as the Indian Institute of Science, Bengaluru, the proportion is even lower.

These figures show that India's most significant pipeline leakage occurs during the transition from academic training to stable research employment and then again at higher levels of institutional advancement.

f. Factors Contributing to the Leaky Pipeline in India

The decline in women's participation in research careers is not caused by a single factor. Rather, it emerges from the interaction of social expectations, structural limitations and institutional barriers.

i. Social Expectations and Life-Cycle Pressures

- The stage at which many women complete doctoral education often coincides with life events such as marriage, childbirth and the beginning of family responsibilities.
- Social norms frequently expect women to prioritise domestic roles over professional advancement.
- As a result, many women take career breaks that interrupt research productivity and weaken long-term career continuity.

ii. Geographic Mobility Constraints

- High-quality laboratories and research institutions in India are concentrated in a limited number of metropolitan or specialised centres.
- Scientific careers often therefore require geographic mobility.
- After marriage or due to family circumstances, many women may be unable to relocate freely, leading to discontinuation of research careers.

iii. Age Limits in Recruitment

- Several research organisations impose strict age limits for entry-level scientific positions.

- Women who take breaks due to maternity or caregiving responsibilities may exceed these limits.
- This reduces their chances of securing permanent research employment even when they remain highly qualified.

iv. Limited Availability of Permanent Research Positions

- India's research ecosystem offers a limited number of stable academic and research positions compared to the number of doctoral graduates.
- Many early-career researchers therefore depend on temporary fellowships, short-term projects or contractual positions.
- Such arrangements often lack job security, promotion opportunities and financial stability, making them especially difficult to sustain over time.

v. The Position Gap

Another structural challenge is the mismatch between the growing number of PhD graduates and the inadequate expansion of permanent research jobs.

- India is producing more trained scientists in science and engineering.
- However, the number of stable academic and research positions has not increased at the same pace.
- This drives many qualified researchers, including women, out of the formal research ecosystem and into alternative careers.

vi. Institutional Barriers

- Although some institutions have introduced gender equity measures, implementation often remains uneven.
- Recruitment processes may lack transparency or sufficient incentives to improve representation.
- Institutional cultures may not always provide adequate mentoring, childcare support or gender-sensitive work environments.

These factors together create a cumulative pattern of attrition, turning the educational strength of women in STEM into a weaker professional presence in science.

This attrition is not merely an issue of representation; it also has serious consequences for the research ecosystem and the national economy.

g. Consequences of the Leaky Pipeline

The loss of women from scientific careers has broad implications for both the research system and national development.

i. Loss of Human Capital

- India invests substantial resources in educating women in STEM disciplines.
- When a significant share of this talent does not translate into long-term research careers, the country suffers a waste of valuable human capital.

ii. Reduced Diversity in Research

- Gender diversity strengthens the quality of research by introducing different experiences, questions and perspectives.
- When women are underrepresented, scientific inquiry may become narrower and less innovative.

iii. Weakening of the National Research Ecosystem

- Underrepresentation of women reduces the overall capacity of the scientific workforce.

- This may slow the development of a robust, competitive and globally relevant research ecosystem.

Thus, the leaky pipeline is not only a gender issue; it is also a question of scientific efficiency, innovation and national capability.

Recognising these challenges, several policy measures have been introduced to support women in science.

h. Policy Measures to Support Women in Science

India has introduced a number of initiatives intended to reduce attrition and support women's participation in research.

i. Re-entry and Fellowship Support

- Programmes such as Women Scientist Schemes aim to help women re-enter scientific careers after interruptions.
- Fellowship schemes also support women pursuing doctoral and postdoctoral research.

ii. Institutional Support Measures

- Some research institutions have introduced maternity support, flexible working arrangements and childcare facilities.
- These measures are intended to make scientific careers more compatible with family responsibilities.

iii. Limits of Existing Measures

- While these initiatives are important, their effectiveness depends on scale, consistency and long-term institutional commitment.
- Without deeper structural reforms, isolated schemes cannot fully resolve the leakage problem.

Therefore, the challenge requires a broader reform agenda that addresses both opportunity structures and institutional culture.

i. Way Forward

Addressing the leaky pipeline requires reforms at multiple levels of the scientific and research ecosystem.

i. Expanding Stable Career Opportunities

- India must increase the number of permanent research and academic positions in universities, laboratories and scientific institutions.
- Stable career pathways are essential for retaining trained women scientists.

ii. Reforming Recruitment Norms

- Recruitment systems should provide age relaxations and flexible eligibility criteria that account for career breaks.
- Women should not be structurally penalised for maternity or caregiving responsibilities.

iii. Strengthening Work-Life Balance Support

- Institutions should provide childcare facilities, flexible working arrangements and family-supportive policies.
- Such measures can help women sustain long-term scientific careers without forced exits.

iv. Building Mentorship and Support Networks

- Women scientists need stronger mentoring systems, peer networks and professional support structures.
- These can help them navigate institutional barriers and career uncertainty.

v. Increasing Visibility of Women in Leadership

- Greater representation of women in senior scientific and administrative positions can provide role models for younger generations.
- Visible leadership also helps reshape institutional cultures and social expectations.

A durable solution therefore requires not only welfare-oriented support but also systemic reforms that make science careers genuinely inclusive.

Conclusion

India's experience in STEM reveals a striking paradox. The country produces one of the largest numbers of female STEM graduates in the world, yet women remain underrepresented in research careers, faculty positions and scientific leadership. The most significant leakage in the pipeline occurs not at the stage of education, but during the transition from education to long-term research employment and upward professional advancement.

Addressing the social expectations, institutional barriers and structural limitations that contribute to this attrition is essential for building a strong, inclusive and globally competitive scientific ecosystem in India. Strengthening women's participation in science will not only advance gender equality but will also enhance the country's capacity for innovation, research excellence and knowledge-driven development.

Reader's Note — About This Current Affairs Compilation

Dear Aspirant,

This document is part of the PrepAlpine Current Affairs Series — designed to bring clarity, structure, and precision to your daily UPSC learning.

While every effort has been made to balance depth with brevity, please keep the following in mind:

1. Orientation & Purpose

This compilation is curated primarily from the UPSC Mains perspective — with emphasis on conceptual clarity, analytical depth, and interlinkages across GS papers.

However, the PrepAlpine team is simultaneously developing a dedicated Prelims-focused Current Affairs Series, designed for:

- factual coverage
- data recall
- Prelims-style MCQs
- objective pattern analysis

This Prelims Edition will be released separately as a standalone publication.

2. Content Length

Some sections may feel shorter or longer depending on topic relevance and news density.
To fit your personal preference, you may freely resize or summarize sections using any LLM tool (ChatGPT, Gemini, Claude, etc.) at your convenience.

3. Format Flexibility

The formatting combines:

- paragraphs
- lists
- tables
- visual cues

—all optimised for retention.

If you prefer a specific style (lists → paras, paras → tables, etc.), feel free to convert using any free LLM.

4. Monthly Current Affairs Release

The complete Monthly Current Affairs Module will be released soon, optimized to a compact 100–150 pages — comprehensive yet concise, exam-ready, and revision-efficient.