Tirumal Classes Quality education

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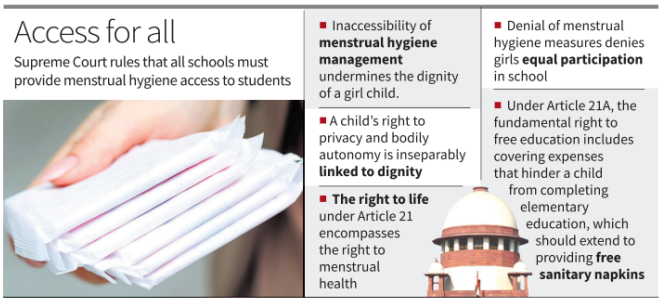
Page 01 : GS II : Indian Polity / Prelims Exam

In a landmark judgment, the Supreme Court of India has categorically held that menstrual health and access to Menstrual Hygiene Management (MHM) in schools are integral to the Right to Life and Dignity under Article 21 of the Constitution. The ruling goes beyond welfare and places menstrual hygiene within the core framework of fundamental rights, bodily autonomy, privacy, and gender equality, giving constitutional depth to an issue long treated as a policy or health concern.

Menstrual health in schools is integral to right to life: SC

The top court says lack of menstrual hygiene management in schools subjects girls to stigma and humiliation; it directs States, Union Territories to ensure access to sanitary napkins in all schools

Krishnadas Rajagopal
NEW DELHI



The Supreme Court on Friday declared that the right to menstrual health and access to menstrual hygiene management (MHM) measures in educational institutions is part of the fundamental right to life and dignity under Article 21 of the Constitution.

"Dignity cannot be reduced to an abstract ideal; it must find expression in conditions that enable individuals to live without humiliation, exclusion, or avoidable suffering. For menstruating girl children, the inaccessibility of MHM measures subjects them to stigma, stereotyping, and humiliation," a Bench of justices J.B. Pardiwala and R. Mahadevan observed in a judgment.

The absence of safe and hygienic menstrual management measures undermined dignified existence by compelling adolescent students to either resort to absenteeism or adopt unsafe practices.

"Both violate the bodily autonomy of girl children... Menstrual poverty hinders girls from exercising their right to education with dignity equal to that of their male counterparts, or students who can afford sanitary products. There is no gainsaying that impairment of primary or secondary education has grave and lasting consequences," the court explained.

The judgment was based on a writ petition filed by Dr. Jaya Thakur, highlighting the lack of MHM measures in schools across the country. The court held that the lack of MHM measures in schools violates the right to privacy and bodily autonomy of students.

Issuing a series of directions, the Supreme Court ordered States and Union Territories to ensure that every school, whether government-run or privately managed, in both urban and rural areas, are provided with functional, gender-segregated toilets. These schools must make oxo-biodegradable sanitary napkins readily accessible to students free-of-cost, preferably within the toilet premises, through sanitary napkin vending machines.

'MHM corners'

Schools must establish 'MHM corners' equipped with, including but not limited to, spare innerwear, spare uniforms, disposable bags and other necessary materials to address menstruation-related exigencies.

"A girl child's expectation to manage her menstruation in privacy with dignity is legitimate. In such circumstances, the lack of resources cannot be permitted to govern her autonomy over her own body," the court noted. It said MHM was not limited to traditionally understood sanitation, but included bodily autonomy and decisional freedom.

"The denial of adequate facilities, appropriate sanitary products, or privacy effectively compels a girl child to manage her body in a manner dictated by circumstance rather than choice. Autonomy can be meaningfully exercised only when girl children have access to functional toilets, adequate menstrual products, availability of water, and hygienic mechanisms for disposal," the court observed.

The court said the state cannot force a child to choose between dignity and her education. Such a choice was neither just nor equitable. The failure to provide sanitary napkins created a gender-specific barrier that impedes attendance, and continuity in education, thereby defeating the substantive guarantee of free and compulsory education.

'Men in menstruation'

In a separate section on the role of 'men in menstruation', the apex court said it was crucial to educate and sensitise male teachers and students about the "biological reality of menstruation" in order to avoid any sort of harassment or invasive questioning of a menstruating student in school.

The court held that the State concerned would be held accountable if government-run schools did not comply with Section 19 (norms for schools, including separate washrooms for boys and girls and barrier-free access) of the Right to Education Act. Similarly, private schools would be de-recognised and face consequences if they did not comply with similar norms prescribed under the RTE Act.

Key Observations of the Court

Article 21 – Life with Dignity : The Court reaffirmed that dignity is not abstract; it must translate into real, enabling conditions. Lack of MHM facilities forces girls into **humiliation, stigma, absenteeism, and unsafe practices**, directly violating dignified existence.

Bodily Autonomy and Privacy: Inadequate menstrual facilities compel girls to manage menstruation based on constraints rather than choice. This violates **bodily autonomy and decisional freedom**, now firmly read into Article 21 jurisprudence.

Education and Gender Justice: Menstrual poverty creates a **gender-specific barrier to education**, undermining substantive equality and the constitutional promise of free and compulsory education. The Court stressed that the State cannot force girls to choose between **education and dignity**.

Accountability of the State and Private Actors

Government schools: State accountability for non-compliance with statutory norms.

Private schools: Threat of **de-recognition** for failure to ensure basic MHM infrastructure. This reflects the Court's insistence that **rights-based obligations apply across public–private divides** in education.

Directions Issued by the Court

Functional, **gender-segregated toilets** in all schools (urban and rural).

Free access to oxo-biodegradable sanitary napkins, preferably via vending machines inside toilet premises.

Creation of **'MHM corners'** with spare uniforms, innerwear, disposable bags, and emergency supplies.

Availability of water and hygienic disposal mechanisms.

Sensitisation of male teachers and students ("men in menstruation") to prevent harassment, stigma, and invasive questioning.

Broader Constitutional and Governance Significance

Shift from Welfare to Rights: Menstrual hygiene is no longer a discretionary policy matter but a **justiciable constitutional obligation**.

Intersectional Justice: The judgment links gender, health, education, privacy, and dignity—reflecting an integrated rights approach.

Human Capital Perspective: By addressing absenteeism and dropouts, the ruling aligns with long-term goals of **female education, workforce participation, and demographic dividend**.

Implementation Challenge: Fiscal capacity, monitoring, and coordination between Centre, States, and school managements will be critical for effective compliance.

Conclusion

The Supreme Court's judgment marks a transformative moment in gender-just constitutionalism. By recognising menstrual health in schools as part of the Right to Life and Dignity, the Court has elevated a routine biological reality into a matter of constitutional morality and social justice. If implemented in letter and spirit, the ruling has the potential to dismantle structural barriers faced by millions of school-going girls and ensure that education in India is truly inclusive, equitable, and dignified—not just in law, but in lived reality.

UPSC Mains Exam Practice Question

Ques: The right to menstrual health and access to menstrual hygiene management (MHM) in schools is intrinsic to the right to life, dignity, and education. In the light of the recent Supreme Court judgment, critically examine the constitutional, social, and governance implications of recognising menstrual health as a fundamental right. **(150 words)**

Page 05 : GS III : Science and Tech

In a significant judgment reinforcing **evidence-based medicine and medical ethics**, the **Supreme Court of India** has held that **stem cell therapy cannot be offered as a clinical service for Autism Spectrum Disorder (ASD)** outside approved and monitored clinical trials. The ruling addresses the growing misuse of experimental therapies, the vulnerability of caregivers, and regulatory inertia, and places patient safety, informed consent, and scientific validity at the centre of healthcare governance.

Stem cell therapy cannot be offered as a clinical service for autism: Supreme Court

The SC says without scientific evidence on efficacy and safety of such therapy, informed consent not possible; it questions the Centre for not acting against those promoting such 'miraculous cure'

Krishnadas Rajagopal
NEW DELHI

Stem cell 'therapies' cannot be offered as a clinical service for Autism Spectrum Disorder (ASD), outside of an approved and monitored clinical trial or research setting, the Supreme Court held in a judgment on Friday.

A Bench of Justices J.B. Pardiwala and R. Mahadevan criticised the Union government for its failure to act against those offering such therapies, which has led parents and guardians to seek an unproven method of treatment for their children suffering from ASD at a huge financial cost.

The court directed the government to constitute a dedicated authority for regulatory oversight over stem cell research across the country.

The Bench held that the therapeutic use of stem cells in ASD cases, based on uncertain scientific knowledge or evidence about its effectiveness as a cure or the possible repercussions, would fail the "reasonable standard of care" that doctors owed their patients.

> There is a dearth of established scientific evidence on the efficacy and safety of therapeutic use of stem cells in Autism Spectrum Disorder. As a result, the doctors do not have 'adequate information' to provide their patients in the first place
> SUPREME COURT

"There is a dearth of established scientific evidence on the efficacy and safety of therapeutic use of stem cells in ASD. As a result, the doctors do not have 'adequate information' to provide their patients in the first place," the court observed.

The court clarified that parents, guardians, and caregivers cannot demand that stem-cell therapy be administered as a clinical service.

"Even consent obtained from patients would not be valid as the prerequisite to disclose adequate information cannot be satisfied," the court said.

Though consent is a mode of exercising patient autonomy, it cannot be "stretched to seek an entitlement to subject oneself to a clinical procedure that is scientifically unvalidated, ethically impermissible, and outside the bounds of reasonable medical practice", the court reasoned

Besides, the court said, 'consent' means an "informed authorisation, grounded in adequate disclosure of the nature, procedure, purpose, benefits, effects, alternatives, substantial risks; and adverse consequences of refusing treatment".

The judgment came on the basis of a series of petitions raising concerns about the rampant promotion, prescription and administration of stem cell therapy for the treatment of ASD by clinics across the country.

The petitioners argued that though stem cell therapy itself is in an experimental stage, it was being touted as a 'treatment' and 'cure' for ASD.

They noted that people diagnosed with ASD and their caregivers place their implicit faith in centres offering stem cell therapy in the hope of a "miraculous cure".

The petitions argued that there was also a lapse on the part of the government in allowing such stem cell therapies, which were in violation of the New Drugs and Clinical Trial Rules, 2019.

Core Findings of the Judgment

Lack of Scientific Evidence: The Court noted a dearth of credible scientific evidence establishing the **efficacy and safety** of stem cell therapy for ASD. In the absence of validated outcomes, such interventions fail the **"reasonable standard of care"** owed by doctors to patients.

Informed Consent is Impossible without Evidence: Consent in medical law is meaningful only when it is **informed**—based on disclosure of benefits, risks, alternatives, and consequences of refusal. Since doctors themselves lack adequate information on outcomes and risks, **valid informed consent cannot be obtained** for stem cell therapy in ASD.

Limits of Patient Autonomy: While patient autonomy is constitutionally protected, the Court clarified that it **does not extend to claiming a right to undergo scientifically unvalidated and ethically impermissible procedures**. Consent cannot legitimise unsafe or experimental treatments masquerading as cures.

Criticism of Government Inaction: The Union government was sharply criticised for failing to curb clinics promoting stem cell therapy as a "miraculous cure", leading to **financial exploitation and false hope** among parents and caregivers.

Key Directions Issued

Ban on Clinical Use: Stem cell therapy for ASD cannot be offered as a routine clinical service; it is restricted to **approved research or clinical trial settings**.

Regulatory Oversight: Direction to constitute a **dedicated national authority** to regulate stem cell research and its applications.

Compliance with NDCTR, 2019: Reinforcement that therapies violating the **New Drugs and Clinical Trial Rules, 2019** are impermissible.

Broader Constitutional and Policy Significance

Ethics in Healthcare: The judgment strengthens the principle that **medical innovation must be guided by ethics, safety, and scientific rigour**, not market incentives.

Protection of Vulnerable Groups: Children with ASD and their caregivers are recognised as particularly vulnerable to misleading claims, requiring enhanced State protection.

Rule of Law in Health Regulation: Highlights regulatory gaps and underscores the State's **positive obligation** to prevent quackery and pseudo-scientific practices.

Precedent for Emerging Technologies: Sets an important benchmark for governance of **new biomedical technologies**, including gene therapy and regenerative medicine.

Conclusion

The Supreme Court's ruling draws a firm constitutional line between **hope and hype in medical science**. By disallowing stem cell therapy for autism as a clinical service without proven safety and efficacy, the Court has upheld **patient dignity, informed consent, and evidence-based practice** under Article 21. For policymakers and regulators, the judgment is a clear call to strengthen oversight mechanisms and ensure that innovation in healthcare advances **within the bounds of science, ethics, and constitutional morality**—not at the cost of vulnerable lives.

UPSC Mains Exam Practice Question

Ques : Critically analyse the role of the Supreme Court of India in regulating emerging medical technologies through constitutional interpretation of Article 21. How does this judgment strengthen the doctrine of reasonable standard of care? **(150 Words)**

Page 05 : GS II : Social Justice

The **Jal Jeevan Mission**, launched to ensure **'Har Ghar Jal'**—safe and adequate drinking water to every rural household—has made remarkable progress in **infrastructure coverage**, with nearly **98% of rural households now having tap connections**. However, a recent **Functionality Assessment of Household Tap Connections (2024)** reveals a critical gap between **coverage and actual service delivery**, raising concerns about usage, reliability, and water quality—key dimensions of sustainable public service provision.

High tap coverage under Jal Jeevan scheme, but lower usage, reliability

Jacob Koshy
NEW DELHI

Almost 98% of rural households covered by the Har Ghar Jal scheme now have taps, but the numbers are significantly lower when it comes to usage and reliability of these taps, according to a periodic survey on public satisfaction with the scheme, commissioned by the Jal Shakti Ministry.

The survey, called the Functionality Assessment of Household Tap Connections, was undertaken in 2024 by private firm IPSOS. It is the third periodic evaluation of the scheme, which effectively started in 2020 and comprises a detailed survey of a small section – 2.37 lakh households – of the 19.3 crore rural households that the scheme covers across India.

The Har Ghar Jal scheme aims to provide 55 litres of potable water per person everyday. Except for Tripura (43%), the overwhelming majority of States reported more than 85% satisfaction with water quality.

The scheme's website says 2.72 lakh of India's 5.8 lakh villages are 'Har Ghar Jal' villages.

Low water flow

Nearly all, or 98% of households in the sample, said water was "available," meaning they had a tap to receive water. However, only 83% said they had actually got water through that tap at least once in the seven days prior to the survey. Goa, Gujarat, Andhra Pradesh, and several Union Territories reported over 97% availability, while Bihar (61%), Uttar Pradesh (72%), and Nagaland (74%) were at the lower end.

Only 80% of households reported getting the sanctioned minimum of 55 litres of water, with Sikkim (24%) and Gujarat (58%) reporting the lowest rate among States. When e-coli, total coliform, and pH levels of the water were tested, only 76% of households met the qualifying criteria. Thus, an assessment of the overall functionality of the scheme, looking at regularity, availability, and cleanliness, showed that just 76% of households were benefiting from the scheme as intended, the report underlined.

An important caveat is that the current edition of the survey only investigated villages which are certified as 'Har Ghar Jal' villages, meaning that the State administration had reported that all households, anganwadis, and administrative buildings in these 19,812 villages had been supplied water through taps. There are, as per the scheme's official dashboard, about 2.72 lakh HGJ villages out of 5.8 lakh total villages in India.

'Not comparable'

In the previous such assessment in 2022, 2.98 lakh households in 13,303 villages were sampled; of these, 40% or 5,298 were Har Ghar Jal (HGJ) villages. "This report is not directly comparable with previous rounds of functionality assessments due to the varying methodological, and environmental circumstances that might have been encountered on the ground," the Jal Shakti Ministry said in a statement.

Key Findings of the Survey

Coverage vs Usage Gap

While **98% households have tap connections**, only **83% received water at least once in the seven days** preceding the survey.

States like **Bihar, Uttar Pradesh, and Nagaland** lag significantly, indicating regional disparities.

Quantity and Reliability Issues

Only **80% households received the mandated 55 litres per capita per day (lpcd)**.

Poor performance in States such as **Sikkim and Gujarat** highlights challenges even in otherwise better-performing regions.

Water Quality Concerns

Tests for **E-coli, total coliform, and pH** showed that only **76% of households** met prescribed water quality standards.

This undermines the core objective of providing *safe* drinking water, not merely piped water.

Overall Functionality

When regularity, adequacy, and quality are combined, **only 76% households** were found to be benefiting from the scheme as intended.

Methodological Caveats

The survey covered only **Har Ghar Jal (HGJ) certified villages**, where States had already declared universal tap coverage.

Hence, results may **overestimate performance** at the national level.

The government has clarified that findings are **not directly comparable** with earlier assessments due to differences in sampling and field conditions.

Governance and Policy Implications

From Access to Outcomes: The findings highlight the shift needed from **infrastructure-led targets** to **service-delivery and outcome-based governance**.

Operation & Maintenance (O&M): Sustained water supply depends on local capacity, funding for maintenance, and source sustainability—areas needing stronger institutional support.

Water Quality Monitoring: Strengthening field-level testing, community participation, and transparency is crucial to address contamination risks.

Federal and Local Coordination: The variability across States underscores the need for better Centre–State coordination and empowerment of **Panchayati Raj Institutions**.

Conclusion

The Jal Jeevan Mission has undeniably transformed rural water infrastructure, marking a significant stride towards **inclusive development and human dignity**. However, the latest functionality assessment underscores that **tap coverage alone does not guarantee water security**. For the mission to achieve its constitutional and developmental promise, policy focus must now pivot to **reliability, adequacy, and safety of supply**, backed by robust monitoring and local capacity-building. Bridging this gap between **"Har Ghar Jal" on paper and in practice** will be decisive for achieving sustainable rural development and public trust in flagship welfare schemes.

UPSC Mians Exam Practice Question

Ques: Despite achieving near-universal tap coverage under the Jal Jeevan Mission, a significant gap persists in water usage, reliability, and quality. Analyse the reasons for this coverage–functionality gap and suggest measures to ensure sustainable drinking water delivery in rural India. **(150 Words)**

In News : Prelims Exam

Recently, India submitted Meghalaya's living root bridges to UNESCO for World Heritage status.

About Living Root Bridges

The living root bridges are locally known as Jingkieng Jri or Lyu Chrai.
These are nestled across the lush southern slopes of the Khasi and Jaintia Hills in Meghalaya.
These are masterpieces of bioengineering created by indigenous communities.
These are grown by indigenous Khasi and Jaintia tribes over a time period of 15 to 30 years.
These bridges range in span from 15 feet to 250 feet, and last for several centuries.

Construction of Living Root Bridges

The bridges are grown by methods of tree-shaping using the aerial roots of Ficus Elastica (Rubber fig tree/Indian rubber tree).
The underlying growth process involves recurring inosculation (joining by twining) of Ficus aerial root fibres over a gorge or river.
The process begins with placing of young pliable aerial roots in hollowed Areca catechu trunks.
These provide essential nutrition and protection from the weather, and also perform as root guidance systems.
This assemblage is structurally supported by a bamboo scaffold, which spans the river and performs as a temporary river crossing for the local community.
Over time, as the aerial roots increase in strength and thickness, the Areca catechu trunks are no longer required.

In News : Prelims Exam

Recently, a rare blood-red auroral activity was captured by the all-sky camera at the Indian Astronomical Observatory in Ladakh's Hanle Dark Sky Reserve.

About Hanle Dark Sky Reserve

Location: It is located at 4,500 metres altitude, in the remote Changthang region of Ladakh.
It is part of the Changthang Wildlife Sanctuary, offering Bortle-1 dark skies (the darkest category).
It was notified in December 2022 by the Government of Ladakh.
It is India's first International Dark Sky Reserve, centred around the Indian Astronomical Observatory (IAO) at Hanle.
It is managed by the Indian Institute of Astrophysics (IIA) under the Department of Science and Technology (DST), Ministry of Science & Technology
The reserve aims to curb light pollution and promote astro-tourism benefiting local communities.
The reserve is a science-driven socio-economic development project, built on two pillars:
Curtailing light pollution in the region
Promoting astro-tourism for local livelihood generation
The UT Ladakh administration supports the project by funding astro-tourism initiatives and light management plans.
Significance of Hanle: Hanle's pristine dark skies and transparent atmosphere allow observing and photographing faint celestial objects that are often impossible from other locations in India.

Green steel can shape India's climate goals trajectory

Sanjiv Paul

is a steel industry veteran and a former Vice-President of Safety, Health and Sustainability at Tata Steel

India stands at a defining moment. Last year, while addressing COP30 delegates in Belém, Brazil, Union Environment Minister Bhupender Yadav committed the country to submit a revised, more ambitious Nationally Determined Contribution (NDC). This is an opportunity for the country to position itself as a leader – not just with a revised pledge, but with clear plans for the economy-wide decarbonisation needed to meet it, including in those sectors that are hardest to decarbonise.

No industry is more critical here than steel.

A chance to lead

As one of the largest growing economies, the steel sector is the cornerstone of India's growth, driving infrastructure and industrial development. In fact, to reach the country's latent potential, steel production would need to more than triple from the current approximately 125 million tonnes a year to more than 400 million tonnes by mid-century. This is unprecedented growth in the given time and will surely come at a cost. The sector accounts for around 12% of the country's carbon emissions today, largely due to its continued reliance on coal.

Much like other emerging economies, India faces a twin challenge of ensuring continued development, while meeting long-term climate targets.

Vital to achieving both of these goals will be avoiding locking in high carbon infrastructure. The investments made in the steel sector today will determine the long-term outlook of the steel industry. Absence of ambition on the transition could lock in billions of dollars of carbon inefficient technologies. This would not only be environmentally disastrous but also render the Indian economy unattractive in the medium to long term.

Global markets have spoken. Around the world, we are seeing countries take important strides to transition the steel sector. China, for example, is slated to ramp up its scrap-based secondary steel making production and investment in green hydrogen to reduce reliance on coal in steel making.

Meanwhile, the European Union has been on the de-carbonising journey for around two decades. Its Carbon Border Adjustment Mechanism (CBAM) is driving the shift to cleaner steel making for those exporting steel to the region.

Countries unable to demonstrate low-carbon production will face steep border charges, risk losing access to premium export markets and being called out as laggards in energy transition that the world really needs to make. Early movers in green steel will secure a decisive competitive advantage. India's steel sector cannot afford to delay. These warnings have long been noted by India's steel sector, which is already taking steps in the right direction. Tata Steel has piloted injection of hydrogen in blast furnaces, scaled renewable power purchase agreements, and explored carbon capture solutions. Meanwhile, JSW Steel and JSPL are exploring green hydrogen integration, while the Steel Authority of India Limited (SAIL) is modernising blast furnaces and exploring low-carbon production routes.

Locking in billions of dollars in carbon inefficient technologies will be environmentally disastrous and harm the Indian economy

This change has been driven from the very top of companies. It requires bold strategic choices and sustained investment in innovation. And while this progress is important, the sector can and should be doing more.

It must move quickly from pilots to demonstration plants, and then to full-scale near zero technologies. Small- and medium-steel manufacturers also have to adapt to the reality of climate emergency by adopting best available technologies and raw materials to produce more carbon efficient steel.

The sector should no longer be investing in business-as-usual high carbon intensive blast furnace technology. All new capacity needs to be low to near zero carbon, as soon as possible.

Policy progress so far

Making these bold moves requires responsible executives and boards to have confidence in the trajectory of the sector. This is where consistent policy signals to guide long-term industrial planning come into play.

India has made important strides to set direction for the steel sector. The release of the government's Greening Steel Roadmap in September last year set a practical pathway for the sector's decarbonisation. This publication of Green Steel Taxonomy in December 2024 made India the first country to formalise such a definition. The National Green Hydrogen Mission, expanding renewable capacity and carbon emission intensity targets for 253 steel units under the Carbon Credit Trading Scheme (CCTS), demonstrates momentum.

Yet, a year on from the Taxonomy launch, the policy incentives to really shift investment away from coal-based blast furnaces are yet to materialise and India risks being the only country to continue to add expensive age-old technologies in its economy.

The barriers to green steel are significant but solvable: limited supply and the high cost of green hydrogen; insufficient renewable energy dedicated to industry; limited availability and the informal nature of the scrap market in India; consistent and assured availability of reasonably priced natural gas as the transition fuel; identification and development of natural carbon sinks for sequestration; lack of long-maturity, low-cost debt for green steel projects and the need to de-risk them; and the need for workforce upskilling and technology support. Many of these are challenges of policy and investment, areas where India has demonstrated rapid transformation when it wanted to, as seen in renewable energy over the past decade.

To seize this opportunity, we need the government to act as a fair regulator for the sector and set clear, stringent short-, medium- and long-term carbon emission targets for industry to plan its capital investments. This would include rolling out the carbon price regime at the earliest, which would provide an appropriate mechanism for dispersing this cost of green steel through the value chain.

In Europe we have seen that near zero emission technologies could become viable only after the carbon price reached $90-$100 a tonne of CO_2. India can learn from this experience when it comes to scheduling its own carbon emission targets.

We need to see the Green Steel Taxonomy socialised well, creation of a domestic market through a public procurement policy for green steel and promotion of greener products with appropriate certification mechanisms and labelling in place.

Natural gas will be a transition fuel for the steel industry as it moves towards hydrogen-based production. The government needs to make natural gas availability for the steel sector a priority. Companies would find it difficult to afford infrastructure for green electricity, green hydrogen or pipelines for natural gas or pipelines for evacuation of captured CO_2 on their own. The government needs to set up hubs in key areas for development of green steel where costs of this infrastructure can be shared.

With low-carbon manufacturing capacities having a capital intensity which is approximately 30% to 50% higher, these policies are expedient and become urgent in the Indian paradigm. Steel producers may need some fiscal support too, to make this transition possible. The smaller players will definitely need some additional support to ensure that the transition is equitable.

A strategic imperative

Green steel can no longer be optional. It is central to India's climate goals, economic future, and global leadership in sustainable industrialisation. India has already demonstrated global leadership in renewable energy deployment, climate diplomacy, and clean-tech scaling. Steel is now the next frontier: a critical test and an unprecedented opportunity.

By combining decisive corporate action with a robust, market-aligned policy framework, India can decarbonise steel, secure economic competitiveness, and shape global industrial standards.

GS Paper III : Environment

UPSC Mains Practice Question: Steel is a hard-to-abate sector, yet central to India's growth story. Discuss how the transition to green steel can reconcile India's developmental needs with its climate commitments. **(250 Words)**

Context :

As India prepares to submit a more ambitious **Nationally Determined Contribution (NDC)** under the Paris Agreement, decarbonising **hard-to-abate sectors** has emerged as a strategic priority. Among these, **steel** occupies a central place due to its critical role in infrastructure, industrialisation, and employment. The article highlights that **green steel**—steel produced with significantly lower carbon emissions—can decisively shape India's climate goals while safeguarding long-term economic competitiveness. This debate gains added urgency in the context of global climate regimes and trade measures.

Why Steel Matters for India's Climate Goals

- India's steel production is expected to **triple from ~125 million tonnes to over 400 million tonnes by mid-century**, reflecting developmental imperatives.
- The sector currently contributes **around 12% of India's total carbon emissions**, largely due to coal-based blast furnace technology.
- Investments made today risk **carbon lock-in** for decades, undermining India's climate commitments under **Paris Agreement**.

Thus, green steel is not merely an environmental choice but a **developmental and strategic necessity**.

Global Context and Competitive Pressures

- The **European Union** has introduced the **Carbon Border Adjustment Mechanism**, which penalises carbon-intensive imports.
- Countries like **China** are expanding scrap-based steel and investing in green hydrogen.
- Failure to transition risks India losing access to **premium export markets** and being labelled a laggard in global energy transition.

Early movers in green steel will enjoy **first-mover advantage**, technology leadership, and trade resilience.

India's Policy and Industry Response

Policy initiatives:

Greening Steel Roadmap (2024) outlining decarbonisation pathways.

Green Steel Taxonomy (2024)—making India the first country to formally define green steel.

National Green Hydrogen Mission and expansion of renewables.

Carbon emission intensity targets for steel units under the **Carbon Credit Trading Scheme**.

Industry actions:

Tata Steel piloting hydrogen injection, renewables, and carbon capture.

JSW Steel and **Jindal Steel and Power Limited** exploring green hydrogen.

Steel Authority of India Limited modernising furnaces and exploring low-carbon routes.

Despite progress, the transition remains **pilot-heavy** and insufficient to shift capital decisively away from coal-based technologies.

Key Challenges in Scaling Green Steel

High cost and limited availability of **green hydrogen**.

Insufficient renewable energy dedicated to industry.

Informal and underdeveloped **scrap steel market**.

Limited access to **long-tenure, low-cost green finance**.

Need for shared infrastructure (pipelines, hydrogen hubs, CO_2 transport).

Workforce upskilling and technology diffusion, especially for MSME steel producers.

These challenges are **policy- and investment-solvable**, as demonstrated earlier in India's renewable energy expansion.

Way Forward: What India Must Do

Set **clear, time-bound emission targets** for steel (short-, medium-, long-term).

Roll out a **credible carbon pricing regime** early to shift investment incentives.

Promote **green steel public procurement**, certification, and labelling to create domestic demand.

Treat **natural gas as a transition fuel** with assured availability.

Develop **green steel hubs** with shared infrastructure.

Provide **fiscal and financial support**, especially for smaller producers, to ensure a just transition.

Conclusion

Green steel is no longer optional—it is a **strategic imperative** for India's climate leadership, economic resilience, and industrial future. As global markets tighten carbon norms, India's choices today will determine whether it emerges as a **leader in sustainable industrialisation** or risks long-term competitiveness through carbon lock-in. By aligning bold corporate action with predictable, market-oriented public policy, India can decarbonise steel, meet its NDC ambitions, and shape global standards for low-carbon growth—turning a climate challenge into a historic opportunity.