

**The Hindu Important News Articles & Editorial For UPSC CSE**  
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**Page 02 : GS III : Environment / Prelims Exam**

The announcement of 'Turtle Trails' in the Union Budget 2026-27 has sparked a significant debate between economic growth via eco-tourism and the biological necessity of "no-go" zones for endangered species. While the government views this as a sustainable way to boost local economies, conservationists fear the anthropogenic (human-caused) pressure could permanently disrupt one of nature's most sensitive spectacles.

## Conservationists apprehensive of 'turtle trails' announced in Budget

**Satyasundar Barik**  
 BHUBANESWAR

The Union Budget's proposal to develop 'turtle trails' along key nesting sites in the coastal areas of Odisha, Karnataka and Kerala has triggered sharp scepticism and concern among conservationists and researchers, who argue that mass nesting sites should be kept free from anthropogenic pressure.

Mass nesting or arribada of endangered Olive Ridley sea turtles is a rare phenomenon, which is recorded only along India and Costa Rica and some handful of beaches in the world. Odisha is home to the world's largest mass nesting ground for Olive Ridley turtles.

Odisha has two mass nesting grounds – Gahirmatha in Kendrapara district and Rushikulya mouth



Olive Ridley turtles mass nesting at Rushikulya river mouth beach at Podampeta in Ganjam district of Odisha. FILE PHOTO

in Ganjam district. No outsider is allowed to visit Gahirmatha as it comes in the proximity of Integrated Test Range (ITR), Chandipur, India's missile testing centre.

Rushikulya used to be visited by a huge number of wildlife enthusiasts. However, the mass nesting was observed to be disturbed by visitors, and the State Forest and Environ-

ment Department brought some restrictions on the number of visitors who were allowed to see the mass nesting from a distance.

A record seven lakh Olive Ridley turtles had laid eggs in the Rushikulya rookery during the eight days of mass nesting in February last year.

"Under no circumstances, neither people nor light

should go to mass nesting sites. There is no ambiguity in the approach. Though I don't know details about turtle trails, it appears that there would be some sort of construction on the beach, which may be temporary, to facilitate visitors," said B. C. Choudhary, a leading researcher of Olive Ridley turtles.

Dr. Choudhary said, "Mass nesting sites should be strictly 'no-go' zone. Nowhere in the world where mass nesting takes place, either photography is allowed or visitors permitted to take flash lights along with them."

Biswajit Mohanty, a wildlife activist who has been working on Olive Ridley turtles for four decades, said: "There has been ample evidence that ecotourism causes harm to nature. In Chilika Lake, large number of tourists in me-

chanised boats venture into the lake in search of endangered Irrawaddy dolphins. The ecotourism has gone out of control. Habitat of dolphins is now disturbed."

"The mass nesting of Olive Ridley turtles is highly sensitive. Turtles get distracted by lights. If a turtle trail through which ecotourism will be permitted is allowed, it would tamper tranquility and alter conditions suitable for mass nesting," Mr. Mohanty said.

"Very limited numbers of tourists should be allowed under stringent conditions that nesting grounds are not disturbed," he further said.

"Mass nesting sites are highly sensitive places. Providing access to these sites required a lot of consultations. However, I have not come across any con-

sultations on the subject before its announcement in Budget 2026-27," he pointed out.

Mr. Mohanty pointed out that rather than coming up with a 'turtle trail', which sounds like a tourism idea, the government should have announced measures to strengthen conservation efforts.

**'Enforcement needed'**  
 According to him, speed boats, which were procured to enforce fishing prohibition during mating of turtles were lying defunct. "The efforts of the government should have been to put in place a robust enforcement mechanism instead of turning the site into an ecotourism hotspot," he said.

When contacted, Chief Wildlife Warden P.K. Jha refused to comment on the issue.

### The Turtle Trail Debate

#### 1. Introduction

In her ninth budget speech, Finance Minister Nirmala Sitharaman proposed the development of ecologically sustainable Turtle Trails along the coasts of Odisha, Karnataka, and Kerala. This initiative aims to place India on the global eco-tourism map by creating structured, safe viewing experiences for the mass nesting (arribada) of Olive Ridley turtles, particularly at world-renowned sites like Gahirmatha and Rushikulya in Odisha.

#### 2. Key Objectives of the Proposal

**Eco-Tourism Boost:** Transforming nesting sites into world-class nature-based tourism destinations to generate local employment.

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## Daily News Analysis

**Infrastructure & Training:** Plans to upskill 10,000 guides (including a pilot project with IIMs) and develop temporary, low-impact infrastructure for visitors.

**Scientific Integration:** Leveraging satellite telemetry and tagging to monitor migratory paths and using data to regulate fishing and tourism zones.

### 3. Critical Concerns of Conservationists

Experts such as B.C. Choudhary and Biswajit Mohanty argue that "sustainable eco-tourism" in mass nesting zones is often an oxymoron due to the following reasons:

**Light Pollution:** Olive Ridleys are extremely sensitive to light. Artificial illumination from trails or tourist activity can disorient nesting females and lead hatchlings away from the sea.

**Anthropogenic Pressure:** Increased footfall leads to sand compaction, which can damage nests and impede the digging process for turtles.

**Disturbance of Tranquility:** Mass nesting requires a strictly "no-go" environment. Conservationists point to the "out-of-control" ecotourism in Chilika Lake (affecting Irrawaddy dolphins) as a cautionary tale.

**Lack of Consultation:** Critics point out that such a major policy shift was announced in the Budget without prior consultation with marine biologists or local conservation committees.

### 4. Comparison of Major Nesting Sites

| Site                 | Location         | Status/Access  |
|----------------------|------------------|--|
| Gahirmatha           | Odisha           | Strict No-Go Zone (near Missile Testing Range)       |
| Rushikulya           | Odisha           | Historically open to visitors; now under restriction |
| Malabar/Konkan Coast | Kerala/Karnataka | Sporadic nesting; proposed for new trails            |

### Way Forward: Balancing "Viksit Bharat" with "Green Growth"

To align this initiative with India's "Green Growth" goals, the following measures are essential:

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**Strict Zoning:** Implementing "No-Go" zones during the core

nesting months (December to March).

**Scientific Monitoring:** Using satellite telemetry to track migratory paths before defining "trail" boundaries.

**Community-Led Conservation:** Instead of commercial tourism, the focus should be on "Turtle Guardians"—local community members trained in protection rather than just guiding.

**Adaptive Management:** Ensuring that infrastructure is purely non-permanent and that visitor numbers are strictly capped based on the carrying capacity of the beach.

### Conclusion

The 'Turtle Trail' initiative presents a classic conflict between development and conservation. While the government's intent to formalize tourism may curb unregulated beach visits, the biological sensitivity of the Olive Ridley demands that "sustainability" be defined by the turtles' needs rather than tourist comfort. For this project to succeed without ecological cost, it must prioritize enforcement of fishing bans and predator control over hospitality infrastructure, ensuring that the "trail" remains a path for conservation rather than a highway for disturbance.

### UPSC Prelims Exam Practice Question

**Ques :** The term 'Arribada', often seen in environmental news, is related to:

- a) Seasonal migration of birds
- b) Mass nesting of sea turtles
- c) Coral spawning phenomenon
- d) Breeding aggregation of whales

**Ans: b)**

### UPSC Mains Exam Practice Question

**Ques:** Examine how unregulated eco-tourism can undermine biodiversity conservation goals. Substantiate your answer with examples from India. **(150 Words)**

**Page 06 : GS II : Indian Polity**

A recent report titled "Death Penalty in India: Annual Statistics 2025", published by the Square Circle Clinic (NALSAR University of Law), highlights a growing divergence between India's lower and higher judiciary regarding capital punishment. While Sessions Courts continue to award death sentences at a high rate, the Supreme Court has entered its third consecutive year without confirming a single death penalty. This trend underscores deep-seated systemic flaws in investigation, trial procedures, and the application of the "Rarest of Rare" doctrine.

# SC has not upheld death penalty in 3 years: report

The top court acquitted 10 death row prisoners in 2025; lower courts handed down 1,310 death sentences over the past decade; high rate of acquittals raises concerns about wrongful convictions

**Ishita Mishra**  
 NEW DELHI

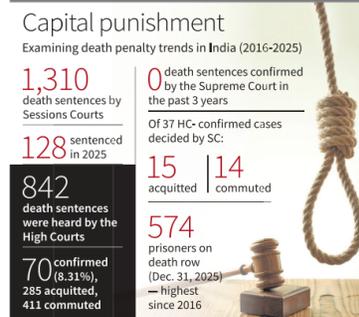
The Supreme Court has not confirmed a single death penalty in the past three years, according to an annual statistics report on death penalties in India, published by the Square Circle Clinic, a criminal justice initiative at the NALSAR University of Law, Hyderabad.

In fact, in 2025, the top court acquitted 10 prisoners who had been on death row, the highest number of such acquittals in the past decade.

The report, which examined death penalty trends across India over the past 10 years, found that the sessions courts handed down 1,310 death sentences nationwide between 2016 and 2025.

"Despite growing judicial scepticism at higher levels," the lower courts sentenced 128 individuals to death in 2025 alone, the report said.

**High rate of acquittals**  
 Of the 1,310 death sentences, 842 verdicts were handed down by the High Courts, of which 70 – that



is, just 8.31% – were confirmed. The High Courts acquitted 285 people on death row, while 411 death sentences were commuted.

The Supreme Court's stance has been even more restrictive, with no death sentence confirmed in the past three years.

Also, in cases where sessions courts imposed death sentences which were confirmed by the High Courts, not a single sentence has yet been affirmed by the Supreme Court.

Of the 37 such death sentences which have been decided by the Supreme Court, 15 resulted in acquit-

tal and 14 were commuted. "What is starkly clear from these figures is that errors at Sessions Courts are not only leading to wrongful imposition of death sentence but are also resulting in wrongful convictions. The high rate of acquittals by the appellate judiciary requires a serious examination of how Sessions Courts deem a case worthy of even a conviction," the report said.

The report also showed that India had 574 prisoners – 550 men and 24 women – on death row as of December 31, 2025. The average time spent on death

row before acquittal was over five years, with some prisoners languishing for nearly a decade before being exonerated.

However, 138 individuals were also removed from death row during the year through acquittals, commutations, or remand orders

One of the report's most alarming findings concerns procedural violations at the sentencing stage.

Despite clear guidelines laid down by the Supreme Court in *Manoj vs State of Madhya Pradesh*, which mandate psychological evaluations, prison conduct reports, and mitigation hearings – which were elevated to a fair trial right requirement in *Vasanta Sampat Dupare vs Union of India* – in 2025, nearly 95% of death sentences in 2025 were imposed without compliance.

Sentencing hearings were frequently conducted within days of conviction, leaving little scope for meaningful defence representation, the report said.

Another emerging trend is the growing use of life imprisonment without remission as an alternative to the death penalty.



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**Key Findings of the Report (2016–2025)**

The data reveals a "bottleneck" effect where death sentences are frequently imposed at the trial level but collapse under appellate scrutiny:

**Trial Court Enthusiasm:** Between 2016 and 2025, Sessions Courts handed down 1,310 death sentences. In 2025 alone, 128 individuals were sentenced to death.

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**High Court Filter:** Of the verdicts reaching High Courts, only 8.31% (70 cases) were confirmed. The rest resulted in acquittals or commutations.

**Supreme Court Restraint:** In 2025, the Supreme Court acquitted 10 death row prisoners—the highest in a decade. Crucially, the top court has not affirmed any death sentence confirmed by a High Court in recent years.

**Death Row Population:** As of December 31, 2025, India has 574 prisoners on death row, reflecting a slow and overburdened appellate process.

### Critical Legal Concerns & Procedural Lapses

#### 1. Violation of Sentencing Guidelines

The report notes that 95% of death sentences in 2025 were imposed without following the mandatory procedural safeguards established by the Supreme Court:

**Manoj v. State of MP (2022):** This judgment mandated that courts must collect comprehensive "mitigating material" (psychological evaluations, prison conduct, socio-economic background) before sentencing.

**Vasanta Sampat Dupare v. Union of India (2025):** The Court recently elevated these guidelines to the status of a "fair trial right," meaning a sentence without these reports is constitutionally infirm.

#### 2. The "Same-Day Sentencing" Issue

Trials often conclude with conviction and sentencing on the same day. This leaves the defense with no time to prepare a "mitigation case" to argue why the prisoner should not be executed, effectively making the sentencing hearing a mere formality.

#### 3. High Rate of Acquittals

The fact that the Supreme Court is acquitting individuals who were previously sentenced to death by two lower courts suggests a crisis of wrongful convictions. This points to poor quality of police investigation and a failure of trial courts to strictly scrutinize evidence.

### Emerging Trends in Jurisprudence

**Life Without Remission:** There is an increasing shift toward "Life Imprisonment for the remainder of natural life" as a middle-path alternative to the death penalty.

**Judicial Scepticism:** The higher judiciary is increasingly wary of the irreversibility of the death penalty, given the fallibility of the trial process.

**Socio-Economic Bias:** Previous reports (Project 39A) have shown that a majority of death row prisoners are from marginalized castes and economically vulnerable backgrounds, raising questions of "Equal Protection of Law."

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**Conclusion**

The 2025 report serves as a grim reminder that while the "Rarest of Rare" doctrine was intended to limit the death penalty, it is often applied mechanically by trial courts. The Supreme Court's current stance reflects a "Safety First" approach, prioritizing the prevention of irreversible errors over retribution.

For a robust democracy, the focus must shift from "more death sentences" to better investigations and meaningful sentencing hearings. As the Law Commission's 262nd Report suggested, the ultimate goal should be the gradual abolition of the death penalty, except in cases of terrorism.

**UPSC Mains Exam Practice Question**

**Ques:** The divergence between trial courts and constitutional courts in awarding death penalty reflects deeper structural flaws in India's criminal justice system. **(150 Words)**

**Page 06 : Prelims Exam**

In a significant boost to India's "Atmanirbhar Bharat" initiative in the defense sector, the Defence Research and Development Organisation (DRDO) successfully flight-tested the Solid Fuel Ducted Ramjet (SFDR) technology.

Conducted at the Integrated Test Range (ITR) in Chandipur, Odisha, this test marks India's entry into a select group of nations capable of developing high-speed, long-range air-to-air missiles. This technology is the backbone for the next generation of Beyond Visual Range (BVR) combat.



**What is SFDR Technology?**

To understand SFDR, we must look at how it differs from traditional missile engines:

**The Ramjet Principle:** Unlike traditional rockets that carry both fuel and an oxidizer, a Ramjet engine "breathes" oxygen from the atmosphere. It uses the missile's forward motion to compress incoming air before combustion.

**Solid Fuel Advantage:** SFDR uses a solid propellant. This makes the system simpler, more reliable, and easier to store compared to liquid-fueled ramjets.

**The "Ducted" Mechanism:** The "ducts" allow air to enter the engine. This allows the missile to maintain Supersonic speeds (Mach 2 to 3) throughout its flight path.

**India enters elite group with successful missile tech test**

The Defence Research and Development Organisation successfully carried out the flight demonstration of Solid Fuel Ducted Ramjet technology from the Integrated Test Range, Chandipur, off the coast of Odisha, on Tuesday. The test was conducted at around 10.45 a.m. According to the Ministry of Defence, with this achievement, India has entered an elite group of nations possessing SFDR technology, a critical capability for the development of long-range air-to-air missiles that significantly enhance combat effectiveness and provide a decisive tactical edge against adversaries. Defence Minister Rajnath Singh congratulated DRDO and the Indian industry partners on the successful demonstration, describing it as a major milestone in the country's missile development programme.

**Technical Breakdown**

| Feature      | Details   |
|--------------|---|
| Objective    | To power Long-Range Beyond Visual Range Air-to-Air Missiles (BVRAAM). |
| Developed By | Defence Research and Development Laboratory (DRDL), Hyderabad.        |
| Key          | Nozzle-less Booster: Helps the missile reach the required             |

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## Daily News Analysis

| Feature                | Details  |
|------------------------|--|
| <b>Innovation</b>      | speed for the ramjet to kick in.   |
| <b>Tactical Edge</b>   | Increases the "No-Escape Zone"—the area where a target cannot outmaneuver the missile. |
| <b>Strategic Group</b> | India joins the US, Russia, China, and France (MBDA Meteor).                           |

### Why is this a Game-Changer?

**Extended Range:** Conventional missiles lose energy as they travel. SFDR missiles provide a continuous thrust, allowing them to hit targets at ranges exceeding 300-350 km.

**High Maneuverability:** Because the engine can "throttle" (control the fuel flow), the missile can save energy for the final phase of the flight to intercept highly agile enemy jets.

**Indigenous Power:** It paves the way for the Astra Mark-3, ensuring India does not have to rely on expensive imports like the European Meteor missile.

### Conclusion

The successful demonstration of SFDR technology is a "Force Multiplier" for the Indian Air Force. It provides a decisive edge over regional adversaries by allowing Indian jets to strike enemy aircraft from a much safer distance. For the UPSC aspirant, this represents a shift from "Buyer's Navy/Air Force" to a "Builder's Navy/Air Force," highlighting India's growing prowess in complex aerospace engineering and hypersonic flight regimes.

### UPSC Prelims Exam Practice Question

**Ques:** Which one of the following best explains the key operational advantage of SFDR-based missiles over conventional solid rocket motor missiles?

- a) Higher payload carrying capacity
- b) Ability to operate in hypersonic regime throughout flight
- c) Sustained thrust during mid-course and terminal phase
- d) Reduced radar cross-section

**Ans:** c)

**Page 07 : Prelims Exam**

Antimicrobial Resistance (AMR) is often described as a "silent pandemic," particularly in a high-burden country like India. Scientists from the Translational Health Science and Technology Institute (THSTI), Faridabad, have achieved a breakthrough by developing a highly affordable, rapid dipstick assay to detect AMR genes in urban sewage.

Published in Nature Communications, this innovation provides a scalable solution for environmental surveillance, allowing public health authorities to track "superbugs" and antibiotic residues in the community before they trigger clinical outbreaks.

**Indian scientists make affordable dipstick test to track AMR in sewage**

Sewage sampling is an ethically acceptable and economically feasible approach to check for AMR in a population likewise, for a nation as populous and vast as India, affordable testing technology is critical to curb the spread of AMR, a key feature of the new assay is its affordability, with a unit cost of ₹400-550

Edries Yousof Hajam

Scientists from the Translational Health Science and Technology Institute (THSTI), Faridabad, have developed an affordable way to check for antimicrobial resistance in sewage.

In their study, detailed in a paper published in *Nature Communications* on December 29, the scientists analysed sewage samples from 381 sites in Assam, Haryana, Jharkhand, Uttar Pradesh, Uttarakhand, and West Bengal, looking for antibiotic residues, microbial diversity, and resistance genes.

Urban sewage in India is known to be a hotspot and reservoir for antimicrobial resistance (AMR), which the team was able to confirm. But equally importantly, the findings validated the scientific test, or assay, the team developed for the purpose, which the team said was affordable without sacrificing efficiency, and thus a solution suitable for use in low- and middle-income countries.

“See with your naked eye”  
 “The workflow to perform the dipstick assay is straightforward,” Deepjyoti Paul, a research scientist at THSTI and the study’s first author, said.

The approach is similar to a rapid diagnostic test, in this case to detect the resistance genes, i.e. those that confer microbes with the ability to resist certain drugs, in environmental sources. Scientists first collect sewage samples and process them to isolate the genetic material, then they amplify the quantities of those genes, for example using the PCR method, so that they are easier to detect.

Then, the amplified genetic material and a detection reagent are added to a dipstick. If the AMR genes are present in the sample, they will bind to the dipstick and produce a band of a visible colour, and thus a clear visual readout.

“The beauty of the dipstick assay is that you can see bands with your naked eye and understand if the sample has a resistance gene or not,” Dr. Paul said.

**Snapshot of antibiotic use**  
 Antibiotics that once worked may become ineffective in treating infections as bacteria develop defenses against one or multiple types of the drugs. As a result, treating resistant pathogens becomes more difficult, reducing the number of treatment options available. AMR pathogens can cause life-threatening infections and create complications following surgery and organ transplantation.

Sewage is a complex environment that offers a snapshot of antibiotic usage and provides an early warning system for resistance development. Samples from sewage can capture upstream signals from communities, hospitals, animal farms, and industries. If certain

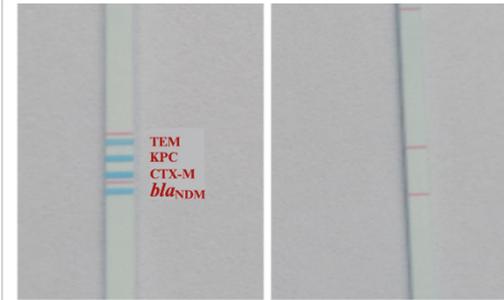
antibiotics or resistance genes are prevalent at a particular location, it can be a sign that medical intervention may be required at the sources upstream. In fact, sewage sampling is considered an ethically acceptable and economically feasible approach to check for AMR in a population.

However, for a nation as populous and geographically vast as India, affordable, time-efficient, and scalable testing technology is critical to curb the spread of AMR. A key feature of the dipstick assay is its affordability, with a unit cost of just around ₹400-550 – far lower than alternatives like shotgun sequencing, whose cost can exceed ₹5,000.

Each dipstick can also recognise 16 different resistance genes from a given sample and deliver results within two hours. In case new resistance genes are discovered anywhere in the world, researchers can also upgrade the dipstick in just three days.

“The dipstick based assay that we developed can easily be adopted in very minimal-resource settings,” THSTI professor and the study’s corresponding author Bhabendra Das said.

According to the authors, the dipstick assay can fill this gap by performing rapid large-scale surveillance to potentially flag a location in the sewage system for deeper investigation and intervention, by researchers, healthcare workers, and the



An image of the dipstick assay in action. The stick on the right is the negative control, for comparison. PAUL ET AL., 2023 (NATURE COMMUNICATIONS)

**TEM KPC CTX-M blaNDM**

The beauty of the dipstick assay is that you can see bands with your naked eye and understand if the sample has a resistance gene or not. DEEPTI PAUL, Research scientist at THSTI

government. The approach also builds on an earlier proof of concept developed in 2017 by researchers in Japan, to detect carbapenemase genes in stool specimens. Dr. Das’s lab adapted the dipstick assay approach for other applications, including to detect microbiota associated with preterm births and to identify and differentiate SARS-CoV-2 variants.

But while the dipstick assay offers rapid insights, experts urged careful interpretation of its results at this stage.

“A gene doesn’t make you unwell,” David Graham, an antimicrobial resistance expert and retired professor at Durham University who now advises the United Nations, said. “A gene just tells you the possibility of an organism being there that might make you unwell.” As he put it: “Genes are like smoke; where there is smoke, there is often fire.”

Because resistance to antibiotics can be a result of different genes or even sets of genes in different countries, he emphasised the need for a deeper understanding of the context.

**Cheaper, faster, scalable**  
 Culturing resistant pathogens and

**THE GIST**

In India, which has become a global hotspot for AMR, the dipstick assay can help perform rapid large-scale surveillance to identify localities in which wastewater treatment is inadequate or where antibiotic use might be high.

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**The Technology: How it Works**

The test simplifies complex genetic analysis into a visual format similar to a home pregnancy or rapid antigen test.

**Process:** Sewage samples are collected and processed to extract genetic material. The target resistance genes are amplified (using PCR) and then applied to the dipstick.

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# Daily News Analysis

**Visual Readout:** If specific AMR genes are present, they bind to reagents on the stick, creating a visible colored band.

**Rapid & Versatile:** Each stick can identify 16 different resistance genes simultaneously within two hours. It can also be "reprogrammed" to detect new emerging resistance genes within just three days.

## Why Sewage Sampling?

**In the context of the One Health Approach, monitoring sewage (Wastewater-Based Epidemiology) is a critical pillar:**

**Early Warning System:** Sewage captures signals from entire communities, animal farms, and hospitals. It acts like "smoke" that indicates where the "fire" (infection/resistance) is located.

**Ethical & Economic:** It avoids the privacy concerns of individual testing and provides a population-level snapshot at a fraction of the cost.

**India as a Hotspot:** With a 72% gap in sewage treatment, untreated waste becomes a reservoir for resistance genes to circulate back into rivers and the food chain.

## Key Comparisons

| Feature        | New Dipstick Assay             | Traditional Shotgun Sequencing |
|----------------|--------------------------------|--------------------------------|
| Cost           | ₹400 - ₹550 per unit           | Over ₹9,000 per sample         |
| Time           | ~ 2 Hours                      | Days to Weeks                  |
| Infrastructure | Minimal resource settings      | High-end genomics labs         |
| Usage          | Routine, large-scale screening | In-depth research/mapping      |

## Significance for India

**Affordability:** Low unit costs make it feasible for Low- and Middle-Income Countries (LMICs) to conduct nationwide surveillance.

**Tracking Pharma Waste:** It can monitor the effectiveness of effluent treatment plants in pharmaceutical hubs (e.g., Hyderabad).

**Policy Support:** Supports the National Action Plan on AMR (NAP-AMR) 2.0 by identifying geographic hotspots for targeted medical intervention.

## Conclusion

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While the dipstick test identifies the presence of resistance genes rather than live pathogens, it is an invaluable first-line defense tool. By providing a cost-effective way to map the "resistome" of Indian cities, this technology bridges the gap between high-end laboratory research and ground-level public health action. For India, which faces the dual challenge of high infectious disease burden and antibiotic misuse, such indigenous innovations are vital to safeguard the future of modern medicine.

**UPSC Prelims Exam Practice Question**

**Ques:** The concept of monitoring antimicrobial resistance through sewage sampling best reflects which of the following approaches?

- (a) Precision medicine
- (b) Curative healthcare
- (c) One Health approach
- (d) Tertiary healthcare model

**Ans:** c)

**Page 10 : GS III : Science and Tech**

The Union Budget 2026-27 signals a phase of cautious consolidation for India's space sector, moving past the "lost years" of the pandemic. With a 182% growth in the national space budget since 2012-13, the current allocation reflects a stabilization of state-led programs.

However, while the fiscal numbers show a 5.3% increase over pre-pandemic peaks, the budget has sparked a debate regarding a perceived gap between the government's pro-privatization rhetoric and the actual structural support provided to non-governmental entities (NGEs).

**How did the space sector fare in the Budget?**

While budget numbers for the space sector suggest that the state-led programme is stabilising, the Finance Ministry has overlooked the structural reforms that industry bodies like the SatCom Industry Association-India and the Indian Space Association have demanded

**ECONOMIC NOTES**

Yasudevan Mukundh

The Indian space program has moved out of its post-pandemic slump and is entering a phase of sustained, if also cautious, consolidation. Since 2012-2013, the national space budget has grown by 182%. While this sounds massive, most of the growth actually happened in the last decade, especially between 2014 and 2019. Allocations have increased more slowly in the last five years. In fact, for a while, the 2019-2020 expenditure of ₹3,077 crore was like a high ceiling that the Department of Space struggled to exceed in actual spending terms, thanks to the COVID-19 pandemic and delays due to missions being rescheduled.

The 2026-27 budget estimate is now 5.3% higher than the pre-pandemic peak, indicating that the 'lost years' of the pandemic are officially over, with the Department finally planning for a scale of operations that actually exceeds its previous historical maximum. In fact, if the expectation for NewSpace India, Ltd. (NSIL) to generate ₹1,403 crore from its own internal resources is included, the expenditure on the total space ecosystem is currently around ₹15,000 crore.

**Structural reforms**

The fiscal roadmap, however, also reveals a disconnect between the government's rhetoric on privatization and financial reality. The budget numbers suggest that the state-led programme is stabilising, but by focusing almost exclusively on direct budgetary support to the Indian Space Research Organisation (ISRO) and administrative costs for IS-SPACE, the Finance Ministry has overlooked the structural reforms that industry bodies like the SatCom Industry Association-India (SIA-India) and the Indian Space Association (ISPA) have demanded.

Leading up to the Budget, these industry associations had coalesced around a specific set of demands designed to make Indian space manufacturing globally competitive. As articulated in pre-budget memoranda submitted by SIA-India and ISPA to the Ministry, the sector desperately needs a Production Linked Incentive (PLI) scheme for space-grade components, echoing the success seen in the mobile manufacturing sector. They further recommended rationalising GST rates for satellite launches to lower entry barriers.

However, the 2026-27 budget is silent on these fronts. There is no PLI scheme to subsidise the high cost of domestic manufacturing nor a dedicated 'space fund' beyond the administrative allocation to IN-SPACE, the nodal supervisor and promoter of non-governmental entities in the space programme. Instead the government has effectively continued its role as a provider of funds to its own agency, ISRO, rather than evolving into the sort of facilitator industry representatives have been asking for. "Given that ISRO is taking a stand that IN-SPACE is the promoting agency, [the latter] should have been allocated at least ₹1,000 crore or so to run its own schemes to support the industry," Narayan Prasad, co-founder of satsearch, the largest supply chain discovery platform in the space industry, told *The Hindu*. "The funding for IN-SPACE would mostly have been to create demand for high-tech platforms like new generation microsatellite bus, and novel payloads and subsystems that can have significant



Private constraints: The PSLV-C52 rocket, carrying an earth observation satellite along with 14 other co-passenger satellites to orbit, is seen at the launch pad at the Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh on January 11, 2019.

service implications."

**'Death valley'**

Roth ISPA and SIA-India have argued that the current GST regime creates a cash-flow problem: space companies pay significant taxes on high-tech imports and raw materials but because their final product is often exempt, they can't claim refunds on these inputs. The result is a hidden 18% tax on manufacturing, which makes 'Made in India' space hardware more expensive than components from jurisdictions with integrated VAT/GST refunds. Both associations have instead demanded a "zero-rated" GST regime, similar to exports, to allow companies to claim full refunds on inputs and thus free up liquidity.

Perhaps the most significant missed opportunity was the refusal to classify the space sector as "critical infrastructure." In its pre-budget submission, ISPA had argued that this classification is essential to access long-term low-cost lending from institutional banks. They estimated that such a status, which would cover ground stations, launch pads, and telemetry networks, would reduce the cost of capital by 2-3% — a difference that could decide if a project is viable in a capital-intensive industry with gestation periods of half a decade or more.

The global space economy is currently transitioning to a high-volume commercial model with smaller margins. India currently holds around 2% of the global space market and the government has resolved to reach 10% by 2029. Without "critical infrastructure" status, however, Indian start-ups will have to continue to borrow at commercial rates

(often 10-12%) while international competitors in the U.S. (SpaceX, Blue Origin) or Europe (Arianespace) are able to access venture debt or state-backed financing at lower interest rates.

Industry members have also highlighted a lack of relief to plug the gap between initial investments in research and development (R&D) and first revenue, colloquially called the "death valley". SIA-India and ISPA have both asked for a five-year tax holiday and tax credits for R&D, to incentivise heavy research spending. Otherwise, the financial risk remains entirely on the private entity and discourages the deep-tech innovation the government claims to want. "It seems like the government is interested in industry but ISRO is not," Mr. Prasad said. "ISRO has neither created significant pathways nor subsidised efforts that allow engagement of startups."

Therefore, industry members state that private firms will likely remain "second-grade" suppliers for ISRO's designs rather than endeavour to develop their own intellectual property. This in turn could prevent disruptive innovation, like reusable rockets or satellite-based IoT, which usually flourishes when private firms have the liquidity to take risks. It could also lead to brain drain.

**'Inertia will continue'**

"India's private space ecosystem is entering a critical growth phase where early-stage capital must bridge the gap between prototype development and commercial scale-up," Debate India had written in a budget expectations report. "Despite rising investor interest since liberalisation in 2020, deep-tech ventures

remain constrained by high hardware burn rates, long gestation timelines and limited private risk appetite."

In the 2024-2025 Budget, the Finance Ministry announced a dedicated Venture Capital (VC) fund of ₹1,000 crore for the space sector to boost the space economy five times over the subsequent decade and to close the "death valley". The Cabinet cleared the setting up of this fund in October 2024 and placed it under the aegis of IN-SPACE. After SEBI approved the fund, the Ministry earmarked ₹150 crore for 2025-2026. However, ISPA and SIA-India have differentiated between equity investment (which the VC fund provides) and fiscal or structural support, such as direct funding for high-risk R&D and for building private launch pads. That is, while the VC fund was a significant move for innovation, even if it was quite small, relative to the industry's needs, as experts noted last year, it doesn't get rid of the capital traps created by the GST regime and the high cost of debt for infrastructure projects.

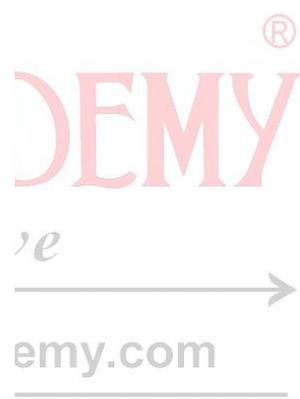
In effect, the government has opened the door to the private sector legally, but financially it has yet to clear the path. The budget stabilises the public space programme, ensuring ISRO has the funds for Gaganyaan and future planetary missions, but has ignored the fiscal levers of GST rationalisation, infrastructure status, and tax holidays, which the industry's own representative bodies have championed. "That it stops short of creating a viable private space market. "Basically this indicates that, this year again, the inertia will continue, with ISRO focusing on activities within itself," Mr. Prasad added.

**THE GIST**

The fiscal roadmap reveals a disconnect between the government's rhetoric on privatization and financial reality.

Both ISPA and SIA-India have argued that the current GST regime creates a cash-flow problem: space companies pay significant taxes on high-tech imports and raw materials but because their final product is often exempt, they can't claim refunds on these inputs. The result is a hidden 18% tax on manufacturing, which makes 'Made in India' space hardware more expensive.

Industry members have also highlighted a lack of relief to plug the gap between initial investments in research and development (R&D) and first revenue, colloquially called the "death valley".



**Key Budgetary Highlights**

| Feature                     | Details  |
|-----------------------------|--|
| <b>Total Allocation</b>     | ₹13,705.63 crore for the Department of Space (DoS).                        |
| <b>Growth Rate</b>          | A modest 2.16% increase over the 2025-26 Budget Estimate.                  |
| <b>Capital Outlay</b>       | Increased to ₹6,375.92 crore, focusing on hardware for Gaganyaan and NGLV. |
| <b>Commercial Arm</b>       | NSIL is expected to generate ₹1,403 crore through internal resources.      |
| <b>Venture Capital Fund</b> | A ₹1,000 crore VC fund (under IN-SPACe) to support startups over 10 years. |

**Major Issues and Industry Demands**

**1. The "Death Valley" Challenge**

The space sector is capital-intensive with long gestation periods (5–7 years). Startups often face the "Death Valley"—the gap between initial R&D and first commercial revenue. Industry bodies like ISpA and SIA-India highlighted that the budget lacked direct tax holidays or R&D tax credits needed to bridge this gap.

**2. Lack of 'Critical Infrastructure' Status**

A major missed opportunity noted by experts was the refusal to classify the space sector as "Critical Infrastructure." Impact: Without this status, startups borrow at commercial rates (10–12%).

Benefit of Status: It would have allowed access to long-term, low-cost institutional lending, potentially reducing the cost of capital by 2–3%.

**3. GST and Fiscal Anomalies**

The current tax regime is described as a "hidden 18% tax" on manufacturing.

The Problem: Companies pay GST on high-tech imports but cannot claim refunds because the final satellite products are often exempt.

The Demand: A "Zero-rated" GST regime, similar to exports, to free up liquidity for domestic manufacturing.

**4. Missing PLI Scheme**

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While sectors like electronics and mobile manufacturing have thrived under Production Linked Incentive (PLI) schemes, the space sector is yet to receive a dedicated PLI for space-grade components, making "Made in India" hardware more expensive than global competitors.

### Strategic Targets for 2030

Global Market Share: India currently holds approximately 2% to 3% of the global space economy (est. \$8.4 billion).

The Goal: To reach 10% share by 2030 (projected \$40-44 billion).

Innovation vs. Inertia: Critics argue that without structural reforms, private firms might remain "second-grade suppliers" to ISRO rather than creators of disruptive intellectual property (IP).

### Conclusion

The 2026-27 Budget ensures that ISRO's flagship missions like Gaganyaan and planetary explorations remain well-funded. However, by sticking to an "inertia model" that prioritizes direct budgetary support over structural facilitators (like GST rationalization and infrastructure status), the path for a truly competitive private space market remains cluttered. To transition from a state-led model to a global commercial hub, the fiscal roadmap must eventually align with the visionary Space Policy of 2023.

### UPSC Mains Exam Practice Question

**Ques:** Examine the structural constraints faced by private space startups in India, with special reference to financing, taxation, and industrial policy. **(150 Words)**

**Page : 08 : Editorial Analysis**

*India's next industrial shift — electrons over molecules*

For over a century, the world's factories, kilns and trucks have been powered by "molecules" – oil, coal and gas burnt for heat and motion. That age is now giving way to one where competitiveness is increasingly written in electrons: clean and reliable electricity. The nations that move the fastest from molecules to electrons will not only cut emissions but also win supply chains, capital and jobs.

On this score, China has opened a decisive lead. It is not merely adding renewables at record pace. It is redesigning industry itself to run on grid power. In 2024, close to half of China's industrial energy came as electricity. India is closer to one quarter. The gap directly affects export competitiveness and resilience to fuel price shocks.

**Why 'electrons vs molecules' is the right lens** Molecules (oil, gas, LPG, coal, biofuels) are combusted directly in engines, boilers and furnaces. Electrons are delivered by the grid. Coal has already shifted role from on-site combustion to centralised power generation. More electrons mean higher automation, better process control and easier decarbonisation.

Electrification also brings a major efficiency dividend. Electric motors convert over 90% of input energy into useful work, while internal combustion engines typically convert less than 35%. This means each percentage point increase in electrons displaces more fuel molecules than raw energy numbers suggest.



**Shrikant Madhav Vaidya**

is an energy strategist and a former Chairman of IndianOil Corporation Ltd.

Electrons spell competitiveness, ensuring clean and reliable electricity, supply chains, capital and jobs, and a cut in emissions

This snapshot is revealing. China draws nearly half its industrial energy from electrons and also has the highest share of green electrons. The United States and world average are around 12% while India lags at just 7%. China leads both in the quantity and the quality of electrons even as India remains molecule-dominated.

At the economy level, China, the U.S. and the European Union (EU) all sit near one-third electrification. But China deliberately channels far more electrons into industry than its peers. This reflects strategic intent. As the world's manufacturing hub, China ensures that factories enjoy reliable power and a rising share of clean electricity. That positioning directly strengthens export competitiveness in markets where carbon intensity is increasingly scrutinised.

**China's transformation; where India is** China's playbook has been to build the grid, then build electron-first industry. China's surge did not happen by accident. Since 2010, it has poured massive capital into generation, ultra-high-voltage transmission, flexible substations and grid-scale storage. The result is a structural tilt toward electrons across industry. In steel, electric-arc-furnace (EAF) steel rose from about 44 million tonnes in 2010 to 106 million tonnes in 2024. Though only approximately 15% of output, this shift has been policy driven through scrap recycling and preferential tariffs.

In cement, China has electrified grinding mills, materials handling and deployed digital controls. Waste-heat-recovery systems typically contribute 30-35 kWh per tonne of cement. Calcination emissions remain unavoidable, making CCUS pilots essential. India can follow a similar pathway.

China's lesson is simple – electrify what can be electrified today, and reserve molecules only for processes that have no immediate alternative.

What is India's starting line like? India has doubled grid capacity in a decade and is a global leader in annual solar additions. Yet, industrial electrons remain around one-quarter of energy use, and green electrons just 7%-8% of final energy. Three factors explain this gap. First, legacy reliance on on-site combustion locks in molecule use. Second, uneven power quality and reliability discourage firms from designing all-electric processes. Third, policy focuses more on generation than on electrifying industrial processes.

This is a road map to an electron-first industrial decade. In steel, India already produces approximately 30% of steel through EAFs, as compared to approximately 70% in the

U.S. Improving scrap collection, standardisation and trading platforms can lift this share rapidly. Renewable-linked EAF incentives are essential, especially with the EU Carbon Border Adjustment Mechanism (CBAM) targeting steel.

In cement, support pilots of electrified kilns, large-scale waste-heat recovery and carbon capture, utilisation, and storage (CCUS) hubs. Target a 20% reduction in molecule use per tonne this decade while preparing CCUS.

On micro, small and medium enterprises (MSMEs), most MSMEs run on coal boilers and diesel gensets. Transition requires concessional finance for electric boilers and induction furnaces, pooled procurement of renewable power purchase agreements, and technical assistance.

When it comes to digitalisation, this must be embedded in new industrial clusters. Advanced controls reduce power waste, enable demand response, and generate auditable carbon data demanded by global buyers.

**Why does this matter beyond climate?**

First, competitiveness as global buyers increasingly demand low-carbon manufacturing. Green electrons embedded in supply chains decide contract outcomes.

Second, security. Shifting heat and motion to domestically produced electricity reduces exposure to imported oil and gas price shocks.

Third, sovereignty. Industry can locate based on skills and logistics, not fuel availability.

**The new industrial race**

The global race is not just electrons versus molecules, but also about green electrons versus grey electrons. China has acted strategically. Although its economy-wide electrification (31%) is similar to the U.S. (32%) and the EU (34%), it prioritised industry – nearly half of industrial energy is electrified, with a higher green share than peers. This design gives China a durable manufacturing edge.

India must absorb this lesson. Without a rapid rise in green electrons, India risks CBAM penalties and lost export opportunities, but with bold action, it can seize the initiative.

Policy must aim not just for megawatts of renewables, but for megawatt-hours actually flowing into industry. India should launch a national mission on industrial electrification, significantly raise annual grid investment, mandate electrification in new industrial parks, and provide targeted MSME finance.

The next industrial revolution will be written in electrons, not molecules. India must ensure that it is not left behind.

**Industrial electrification snapshot**

Green and grey electrons versus molecules

**Global picture: industrial electrons and their quality**

| Region    | Green electrons (%) | Grey electrons (%) | Total electrons (%) | Molecules (%) |
|-----------|---------------------|--------------------|---------------------|---------------|
| China     | 18                  | 29                 | 47                  | 53            |
| The EU    | 16                  | 18                 | 34                  | 66            |
| U.S.      | 12                  | 20                 | 32                  | 68            |
| India     | 7                   | 20                 | 27                  | 73            |
| The world | 12                  | 18                 | 30                  | 70            |

**Whole-economy context**

| Region    | Green electrons (%) | Grey electrons (%) | Total electrons (%) | Molecules (%) |
|-----------|---------------------|--------------------|---------------------|---------------|
| China     | 12                  | 19                 | 31                  | 69            |
| U.S.      | 13                  | 19                 | 32                  | 68            |
| The EU    | 17                  | 17                 | 34                  | 66            |
| India     | 8                   | 19                 | 27                  | 73            |
| The world | 12                  | 18                 | 30                  | 70            |

**GS Paper III : Environment**

**UPSC Mains Practice Question:** Industrial electrification is emerging as a strategic imperative rather than merely a climate policy. Discuss this statement in the context of India's steel, cement, and MSME sectors. **(250 Words)**

## Context :

The global industrial landscape is undergoing a fundamental transition from a "molecule-based" economy (reliance on combustible fuels like coal, oil, and gas) to an "electron-based" economy (reliance on clean electricity). According to energy strategist Shrikant Madhav Vaidya, the speed of this transition will determine future export competitiveness, job creation, and energy security. For India, this isn't just a climate goal but a strategic necessity to avoid carbon-related trade barriers and fuel price volatility.

### Core Concept: Why 'Electrons' Win

**The shift is driven by a massive efficiency dividend.**

**Energy Conversion:** Electric motors convert over 90% of input energy into useful work, whereas internal combustion engines (ICE) struggle to exceed 35%.

**Process Control:** Electrons allow for higher automation and precise digital control compared to the blunt force of combustion.

### Global Benchmarking: The India-China Gap

The following data highlights the structural tilt in industrial energy composition as of 2024:

| Region        | Industrial Electrification Share | Share of 'Green' Electrons |
|---------------|----------------------------------|----------------------------|
| China         | ~50%                             | Highest globally           |
| World Average | ~25%                             | ~12%                       |
| United States | ~25%                             | ~12%                       |
| India         | ~25%                             | 7% - 8%                    |

**Key Insight:** While China's overall economy-wide electrification (31%) is similar to the US (32%), it has strategically prioritized industry, giving its manufacturing sector a decisive edge in cost and carbon footprint.

### Sector-Specific Roadmap for India

#### 1. Steel (The CBAM Factor)

With the EU's Carbon Border Adjustment Mechanism (CBAM) looming, Indian steel must decarbonize.

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Current Status: India produces ~30% of steel via Electric Arc Furnaces (EAF), compared to 70% in the US and 15% in China.

Action: Improve scrap recycling and provide renewable-linked EAF incentives.

### 2. Cement

Strategy: Electrify grinding mills and material handling.

Innovation: Deploy Waste-Heat-Recovery (WHR) systems (contributing 30-35 kWh per tonne) and Carbon Capture (CCUS) for unavoidable calcination emissions.

### 3. MSMEs (The Weakest Link)

Small industries still rely on diesel generators and coal boilers.

Need: Concessional finance for electric boilers and induction furnaces to replace legacy molecule-based systems.

### Challenges to India's Transition

**Legacy Lock-in:** Existing infrastructure is built for on-site combustion of molecules.

**Power Quality:** Uneven grid reliability discourages firms from moving to 100% electric processes.

**Policy Gap:** Current policies focus heavily on generation (adding Megawatts) rather than industrial process electrification (Megawatt-hours consumed).

### Conclusion [www.lakshyaacademy.co](http://www.lakshyaacademy.co) | [www.lakshyaaiasacademy.com](http://www.lakshyaaiasacademy.com)

The race for the next industrial revolution is not just about producing more power, but about ensuring that power is green and flows directly into the factory floor. For India, moving from a molecule-dominated system to an electron-first decade is essential to protect its Sovereignty (reducing oil imports) and Competitiveness (meeting global low-carbon demands). If India fails to raise its share of green electrons, it risks being penalized in the global market; if it succeeds, it can leapfrog legacy industrial models.