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ASPIRE with RAM IAS

Guiding Dreams, Empowering Future

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EXCLUSIVE CURRENT AFFAIRS BULLETIN

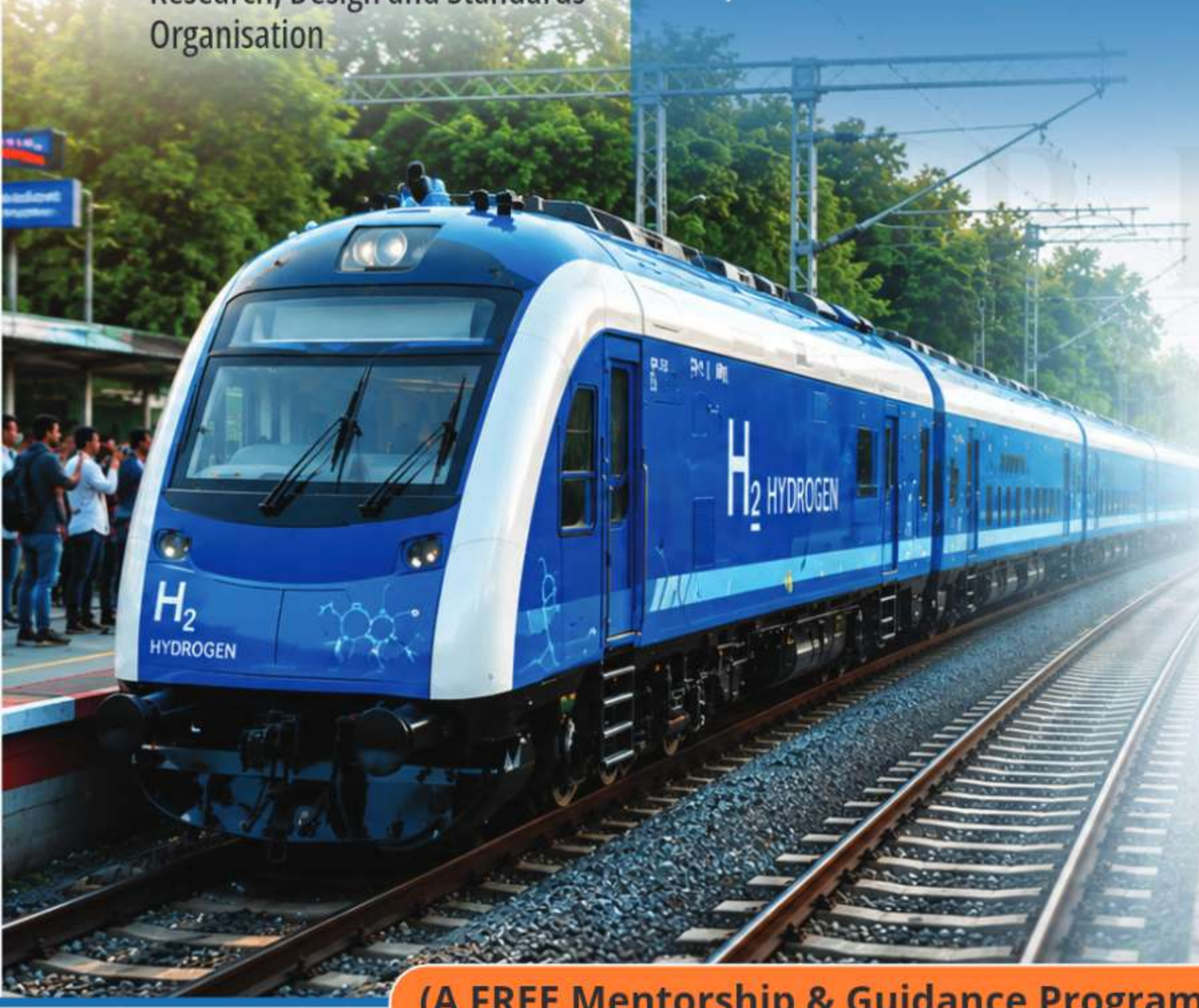
# INDIA'S FIRST HYDROGEN POWERED TRAIN

## Project Snapshot

- Name: NaMo Green Rail / India's first Hydrogen Fuel Cell Powered Trainset
- Route: Jind–Sonipat section, Northern Railway, Haryana
- Launch: 17 July 2026
- Formation: 10 coaches—two Hydrogen Driving Power Cars and eight Trailer Coaches
- Power: Each power car produces 1,200 kW; combined propulsion capacity is 2,400 kW, roughly 3,200 horsepower
- Operational speed: Maximum approved operating speed of 75 kmph
- Design speed: 110 kmph
- Development: Designed, engineered and integrated in India
- Standards role: Technical specifications prepared by the Research, Design and Standards Organisation

## Why in News?

- On 17 July 2026, the Prime Minister flagged off India's first hydrogen-powered train, named 'NaMo Green Rail', from Jind in Haryana.
- The train operates on the Jind–Sonipat section of Northern Railway, a route described as approximately 89–90 km in different official and secondary releases.
- The project places India among the small group of countries that have deployed or tested hydrogen-powered passenger trains.
- It is important as an indigenous demonstration of hydrogen propulsion, refuelling, storage, safety, } operation and maintenance under Indian conditions.




- Project nature: Technology demonstration and pilot for future deployment

## Purpose of the Demonstration Project

- Validate hydrogen fuel-cell propulsion in Indian climate, dust, heat, vibration and passenger-load conditions.
- Test high-pressure hydrogen storage, transfer, refuelling speed and depot infrastructure.
- Develop safety standards, emergency response, inspection and certification procedures.
- Create operating protocols for drivers, station staff, maintenance teams and control offices.
- Build indigenous knowledge in fuel-cell integration, power electronics, batteries, controls and rolling stock.
- Generate evidence on reliability, lifecycle cost, fuel consumption, availability and maintenance.
- Guide decisions on whether and where hydrogen trains should be deployed at larger scale.

## How a Hydrogen Fuel-Cell Train Works

### 4.1 Energy pathway

- Hydrogen is produced outside the train and compressed for storage.
- It is transported or generated near the railway depot and stored in a dedicated hydrogen facility.
- High-pressure tanks onboard the train supply hydrogen to the fuel-cell system.
- Air supplies oxygen to the fuel cell.
- The fuel cell generates direct-current electricity through an electrochemical reaction, without burning hydrogen in an engine.
- Power electronics condition and distribute electricity to traction motors and auxiliary systems.
- Lithium iron phosphate batteries absorb

regenerative-braking energy and support acceleration and rapidly changing loads.
- Electric traction motors turn the wheels.
- At the point of use, the principal reaction outputs are water and heat.

### 4.2 Proton Exchange Membrane Fuel Cell

- Hydrogen reaches the anode, where a catalyst separates it into protons and electrons.
- The membrane permits protons to pass but forces electrons through an external circuit, producing electricity.
- At the cathode, protons, electrons and oxygen combine to form water.

### 4.3 Why the battery is needed

- Fuel cells operate most efficiently under relatively steady loads, while trains need sudden power during acceleration.
- The battery supplies peak power, smooths load variations and captures energy during regenerative braking.
- A hybrid fuel-cell–battery architecture can reduce fuel-cell size, improve efficiency and extend component life.

## Hydrogen Colours and Climate Impact

- Grey hydrogen: Usually produced from natural gas without capturing carbon dioxide; high lifecycle emissions
- Blue hydrogen: Fossil-based hydrogen combined with carbon capture and storage; emissions depend on capture rate and methane leakage
- Green hydrogen: Produced by electrolysis using renewable electricity; lowest-emission option when the electricity and water systems are sustainable
- Pink hydrogen: Produced using nuclear electricity

## Environmental Significance

- Direct fuel-cell by-products are water vapour and heat, with no tailpipe carbon dioxide, soot or particulate smoke.
- Local nitrogen-oxide emissions are avoided because the fuel cell does not burn hydrogen in a combustion engine.
- Noise and vibration may be lower than diesel traction, improving passenger and community comfort.
- Hydrogen can displace diesel on routes where full electrification is technically difficult or economically unattractive.
- The project can create early demand for green hydrogen and encourage renewable-energy integration.
- Rail decarbonisation supports India's climate commitments and the broader objective of net-zero carbon emissions by Indian Railways.

### 6.1 Environmental limitations

- Grey hydrogen can produce substantial upstream emissions and may offer limited climate advantage over efficient diesel or electric alternatives.
- Electrolysis requires electricity; if grid power is fossil-heavy, total emissions rise.
- Green-hydrogen production consumes water, which requires careful siting and treatment in water-stressed regions.
- Compression, cooling, transport and storage consume additional energy.
- Hydrogen leakage can indirectly influence atmospheric chemistry and warming; leak control matters.
- Fuel cells and high-pressure tanks require materials whose production also has environmental impacts.

## 7. Safety and Regulation

- Hydrogen has a wide flammability range, low ignition energy and a flame that can be difficult to see.
- Its small molecules can leak through tiny gaps, making high-quality seals, sensors and inspection essential.
- Compressed storage creates high-pressure hazards.
- Hydrogen can cause embrittlement in some metals, weakening materials over time.

### 7.1 Safety systems

- Hydrogen-compatible tanks, pipes, valves and materials.
- Continuous leak detection and automatic alarms.
- Forced or natural ventilation to prevent gas accumulation.
- Automatic isolation valves and emergency shutdown.
- Pressure-relief devices and controlled venting.
- Fire detection, earthing, lightning protection and explosion-safe electrical equipment.
- Crashworthiness, separation of passenger areas and protected tank placement.
- Regular inspection, staff training, drills and coordination with fire and district authorities.

### 7.2 Regulatory institutions

- RDSO: Develops railway technical specifications, standards, testing and approval frameworks
- PESO: Approved the hydrogen-storage

## • PM TO FLAG OFF HYDROGEN TRAIN ON JULY 17

**India joins elite group, only Japan, South Korea, the US and Canada have H-trains**

| Stations | Distance | Travel time |
|---|---|---|
| 12 | 89 km | 2 hours |

Operational speed: **75 kmph** | Maximum Speed: **120 kmph**

**TRAIN TIMING**

**Train no 74010**
Leave Jind railway station at **7.40 am** and arrive at Sonipat at **9.40 am**

**Train no 74009**
Leave Sonipat railway station at **10.40 am** and reach Jind at **1.00 pm**

| Total seats | Coaches |
|---|---|
| 682 | 10 |

- Passenger capacity: **2,600**
- Power: **2400 kW**

**Zero $CO_2$ emissions and the only emission is water vapour**


**What is it?**

Hydrogen trains, often referred to as 'hydrail' or 'H-trains' provide a viable alternative to diesel locomotives on non-electrified railway routes. The hydrogen fuel cells generate electricity chemically, meaning the only emission is harmless water vapour

**"The train will operate as a special inaugural service on July 17. The date for the commencement of its regular passenger service has not yet been decided,"**
**SENIOR RAILWAY BOARD OFFICIAL**

and supply system; regulates petroleum, compressed gases and explosive safety
- TÜV SÜD, Germany: Independently assessed the project's safety systems
- Indian Railways / Railway Board: Operational approval, rolling-stock sanction and deployment.

## 8. Dedicated Hydrogen Infrastructure

- A hydrogen train requires more than rolling stock; it needs a complete fuel ecosystem.
- The Jind facility includes hydrogen production or receipt, purification, compression, storage, dispensing and safety systems.
- Refuelling must be reliable and fast enough to meet railway timetables.
- Depot layout must separate hazardous operations, maintain ventilation and allow emergency access.
- Hydrogen quality must meet fuel-cell specifications because impurities can damage catalysts and reduce performance.
- Renewable power, water treatment, maintenance capability and trained staff determine whether operations are genuinely sustainable.

## 9. Link with National Green Hydrogen Mission

- The National Green Hydrogen Mission was approved in January 2023.
- It aims to make India a global hub for production, use and export of green hydrogen and its derivatives.
- The Mission supports domestic electrolyser manufacturing, green-hydrogen production, pilot projects, hubs, standards, research and skills.
- Transport pilot projects—including railways—help demonstrate demand and build standards before large-scale commercial adoption.
- Hydrogen trains can serve as anchor consumers near hydrogen hubs, but long-term procurement should favour certified low-emission hydrogen.

## 10 . Strategic and Economic Significance

- Indigenous capability: Builds knowledge in fuel cells, batteries, control systems, storage and railway integration.
- Energy security: Green hydrogen can reduce diesel dependence and exposure to imported petroleum.
- Industrial opportunity: Creates demand for electrolysers, tanks, valves, sensors, compressors, power electronics and specialised services.
- Standards leadership: Operational experience can help India frame safety and performance standards.
- Export potential: Successful indigenous systems may serve countries with non-electrified regional rail networks.
- Skill creation: Requires technicians and engineers trained in electrochemistry, high-pressure gases, electronics and safety.
- Regional development: Hydrogen production and refuelling facilities can attract clean-energy investment.


## 11. Major Challenges

- High green-hydrogen cost: Renewable electricity, electrolysers, compression and storage make fuel expensive.
- Low energy efficiency: Electricity-to-hydrogen-to-electricity loses more energy than direct electrification.
- Infrastructure cost: Each operating region needs production or delivery, storage and refuelling facilities.
- Limited availability: India's green-hydrogen market and certification system are still developing.
- Safety perception: Public acceptance depends on transparent standards and incident-free operation.
- Technology durability: Fuel cells, batteries and tanks must withstand heat, dust, vibration and intensive railway duty.
- Maintenance skills: Specialised staff, tools and spare parts are required.
- Water demand: Electrolysis and purification require responsible water planning.

## 12. Way Forward

- Complete transparent pilot evaluation covering safety, availability, fuel use, reliability, emissions and passenger service.
- Compare hydrogen with diesel, battery and electrification alternatives on a route-by-route lifecycle basis.
- Procure certified green hydrogen and publish its electricity and emissions profile.
- Use renewable power and recycled or non-potable water where feasible.
- Develop Indian standards for tanks, refuelling, leak detection, fire safety, maintenance and emergency response.
- Strengthen domestic manufacturing of PEM fuel cells, electrolysers, power electronics, LFP batteries and composite tanks.

## Conclusion

India's first hydrogen-powered train marks an important step from technology import towards indigenous clean-rail innovation. It can reduce diesel use and build capability in fuel cells, storage, batteries and green-hydrogen infrastructure, particularly for routes where electrification is difficult. Yet hydrogen is not automatically green or universally efficient: responsible scaling requires certified renewable hydrogen, strict safety systems, transparent lifecycle assessment and comparison with battery and electric traction. The Jind–Sonipat pilot should therefore be treated as a learning platform for evidence-based railway decarbonisation.

## Practice Questions

### Prelims MCQ

**Question With reference to India's first hydrogen-powered train, consider the following statements:**

**1. It uses Proton Exchange Membrane fuel cells.**
**2. Hydrogen is burnt directly in an internal-combustion engine to power the train.**
**3. Lithium iron phosphate batteries support acceleration and variable power demand.**
**4. Its lifecycle emissions are independent of the method used to produce hydrogen.**

**Which of the statements given above are correct?**
**(a) 1 and 3 only (b) 1, 2 and 3 only (c) 2 and 4 only (d) 1, 3 and 4 only**

**Answer: (a) 1 and 3 only.**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# QDENGA

## 1. Why in News?

- On 21 July 2026, the Central Drugs Standard Control Organisation (CDSCO), under the Ministry of Health and Family Welfare, announced marketing authorisation for Qdenga, India's first approved dengue vaccine.
- The approval is significant because India carries a high dengue burden and reported cases have risen sharply over the past two decades.
- Urbanisation, population growth, climate variability, water-storage practices, construction activity and expanding mosquito habitats have increased transmission risk.
- The vaccine is expected to become another tool in India's dengue response, alongside vector control, surveillance, early diagnosis and case management.

## 2. Qdenga: Complete Profile

- Generic / development name: TAK-003
- Developer: Takeda
- Manufacturer: Takeda GmbH, Germany
- Indian importer: Takeda Biopharmaceuticals India Pvt. Ltd.
- Vaccine class: Recombinant, live-attenuated, tetravalent dengue vaccine
- Target viruses: DENV-1, DENV-2, DENV-3 and DENV-4
- India indication: Prevention of dengue disease in individuals aged 4–60 years
- Previous infection: India's approval does not require proof of an earlier dengue infection
- Dose: 0.5 mL by subcutaneous injection.

## 3. How the Vaccine Is Designed

- Qdenga contains weakened, replication-competent versions of all four dengue serotypes; attenuation reduces their disease-causing ability while allowing an immune response.
- The DENV-2 strain forms the genomic backbone.
- For DENV-1, DENV-3 and DENV-4 components, genes encoding serotype-specific surface proteins are engineered into the attenuated DENV-2 backbone using recombinant DNA technology.
- The vaccine therefore presents antigens from all four serotypes and aims to generate both antibody-mediated and cellular immunity.
- Because it is a live vaccine and contains genetically modified organisms, manufacture, quality control, cold chain, reconstitution and administration require strict standards.

## 4. Regulatory Approval in India

- CDSCO is India's national regulatory authority for drugs, vaccines, medical devices and cosmetics; the Drugs Controller General of India heads its central regulatory functions.
- Approval followed scientific evaluation of quality, safety, immunogenicity and efficacy.
- The legal basis cited by the government is the Drugs and Cosmetics Act, 1940, and the Drugs Rules, 1945.
- Clinical evidence came from a global programme across endemic and non-endemic regions and included a pivotal Phase III safety and immunogenicity study in Indian participants aged 4–60 years.
- Marketing authorisation permits sale subject to conditions; it does not automatically place the vaccine in the Universal Immunisation Programme.
- Any population-level introduction requires policy assessment of disease burden, epidemiology, safety, effectiveness, cost-effectiveness, supply, delivery capacity and equity.

### 4.1 Institutional roles

- CDSCO / DCGI: Regulatory review, marketing authorisation and post-marketing oversight
- Ministry of Health and Family Welfare: National health policy and programme coordination
- NTAGI: Evidence-based advice on vaccine introduction and use in India
- NCVBDC: Vector-borne disease surveillance, prevention and control
- States and urban local bodies: Field surveillance, source reduction, fogging where indicated, clinical response and public communication
- WHO: Normative guidance, position papers and vaccine prequalification


## 5. Evidence on Efficacy & Safety

- The pivotal Phase III trial enrolled more than 20,000 children aged 4–16 years at 26 sites in eight dengue-endemic countries.
- The trial assessed prevention of virologically confirmed dengue and

dengue-related hospitalisation after two doses three months apart.
- Protection was strong overall, especially against hospitalisation, but differed by serotype and by whether participants had dengue antibodies before vaccination.
- WHO evidence reviews found high protection against DENV-2 and meaningful overall benefit in high-transmission populations.
- Evidence is less certain for DENV-3 and DENV-4 among persons who were seronegative before vaccination; this is why WHO recommends targeted programme use rather than universal mass vaccination.

## 6. Dengue: Disease Profile

- **Causative agent:** Dengue virus, an enveloped positive-sense single-stranded RNA virus of genus Flavivirus
- **Serotypes:** DENV-1, DENV-2, DENV-3 and DENV-4
- **Primary vector:** Infected female Aedes aegypti; Aedes albopictus is an important secondary vector
- **Vector behaviour:** Usually bites during the day, breeds in clean stagnant water in artificial containers and is adapted to urban environments
- **Other diseases spread by Aedes aegypti:** Chikungunya, Zika and yellow fever
- **Geography:** Tropical and subtropical regions, especially urban and semi-urban settings
- Infection with one serotype generally gives long-lasting immunity to that serotype but only temporary cross-protection against the others.
- A later infection with a different serotype can carry greater risk of severe dengue, partly because non-neutralising antibodies may enhance viral entry into immune cells—antibody-dependent enhancement.
- Humans are the main amplifying host in the urban transmission cycle; infected travellers can move the virus between areas.

## 7. Symptoms, Warning Signs and Management

### Common symptoms

- Sudden high fever, severe headache, pain behind the eyes, muscle and joint pain, nausea, vomiting, swollen glands and rash.
- Many infections are asymptomatic or


mild; symptomatic illness often lasts about two to seven days.

### Warning signs of severe dengue

- Severe abdominal pain, persistent vomiting, rapid breathing, bleeding gums or nose, blood in vomit or stool, extreme thirst, pale or cold skin, weakness, fatigue or restlessness.
- Warning signs often appear as fever falls and can indicate plasma leakage, shock, severe bleeding or organ impairment.

### Treatment principles

- There is no specific antiviral treatment for uncomplicated dengue; timely supportive care and careful fluid management reduce mortality.
- Early diagnosis, monitoring of warning signs and referral are critical.
- Aspirin and ibuprofen are generally avoided because they can increase bleeding risk; clinical treatment must follow professional guidance.

## 8. Significance for India

- Adds a biomedical prevention tool for a disease that causes seasonal outbreaks, hospital pressure and productivity loss.
- May reduce symptomatic disease and hospitalisation in carefully selected high-burden populations.
- Can support risk-based, district-level policy rather than one uniform national strategy.
- Encourages stronger disease surveillance, seroprevalence studies, pharmacovigilance and laboratory capacity.
- Creates an opportunity for vaccine diplomacy, manufacturing and supply-chain participation.

## 9. Challenges and Concerns

- Uneven epidemiology: Transmission intensity differs between and within States; a national average can hide local risk.
- Serotype variation: Vaccine performance is not identical against all four serotypes or across baseline serostatus.
- Affordability and equity: Private availability alone may leave high-risk low-income communities behind.
- Two-dose completion: A three-month interval requires reliable tracking, reminders and follow-up.
- Cold chain and reconstitution: Live freeze-dried vaccine needs trained staff, temperature control and safe handling.
- Safety monitoring: Large-scale use needs active surveillance, causality assessment and transparent communication.
- Public confidence: Overstatement or confusion with Dengvaxia may produce hesitancy or false reassurance.

## Conclusion

Qdenga's approval is an important advance in India's fight against a rapidly expanding, climate-sensitive disease. Its broad Indian licence, two-dose schedule and absence of mandatory prior-infection testing make deployment easier, but WHO's narrower programme advice and serotype-specific evidence demand caution. India should use the vaccine selectively where burden is high, ensure affordability and rigorous safety monitoring, and retain vector control, urban sanitation, surveillance and timely treatment as the foundation of dengue prevention.

## Civil Services Practice Questions

### Prelims MCQ

**Question With reference to Qdenga (TAK-003), consider the following statements:**

**1. It is a live-attenuated tetravalent dengue vaccine.**
**2. It uses DENV-2 as its genomic backbone.**
**3. WHO recommends its universal programme use for all persons aged 4–60 years.**
**4. India's approved schedule consists of two subcutaneous doses three months apart.**

**Which of the statements given above are correct?**

**(a) 1 and 2 only (b) 1, 2 and 4 only (c) 2, 3 and 4 only (d) 1, 2, 3 and 4**

**Answer: (b) 1, 2 and 4 only.**

# VIKRAM-1

*Charting India's Cosmic Future*


## 1. Why in News?

- Skyroot Aerospace successfully launched Vikram-1 under Mission Aagaman and achieved India's first orbital launch by a privately developed launch vehicle.
- ISRO recorded lift-off from the First Launch Pad of Satish Dhawan Space Centre, Sriharikota, at 12:05:30 PM on 18 July 2026.
- The mission placed the SCOPE and Grahaa satellites in Low Earth Orbit; other payloads attached to the upper stage were intended to conduct in-orbit experiments.
- It was Skyroot's first orbital attempt and followed the Vikram-S suborbital technology demonstration of November 2022.
- The event is important because a private Indian firm moved beyond component supply and suborbital testing to execute an end-to-end orbital launch mission from Indian soil.

## 2. Mission Aagaman: Fast Facts

- Launch vehicle: Vikram-1, also written as Vikram-I in the official ISRO mission report
- Mission name: Aagaman
- Developer: Skyroot Aerospace, a Hyderabad-based Indian space startup and space-sector unicorn
- Name honours: Dr Vikram Sarabhai, regarded as the father of India's space programme
- Launch date: 18 July 2026
- Launch site: First Launch Pad, Satish Dhawan Space Centre, Sriharikota, Andhra Pradesh
- Mission type: Maiden orbital flight of the Vikram-1 vehicle
- Vehicle configuration: Four stages—three solid-propellant stages and one liquid-propellant upper stage
- Designed service: Launch of small satellites into Low Earth Orbit
- Official payload capability: PIB gives 350 kg to LEO
- Planned altitude: About 450 km for Mission Aagaman
- Confirmed orbital payloads: SCOPE and Grahaa
- Regulatory facilitator: Indian National Space Promotion and Authorisation Centre, or IN-SPACe
- Technical and launch support: Indian Space Research Organisation, or ISRO

## 3. Why Orbital Launch Is More Difficult Than Suborbital Flight

- A suborbital rocket rises to space or near-space on an arc but lacks the sideways velocity needed to keep falling around Earth; it eventually returns.
- An orbital launcher must gain sufficient altitude and very high horizontal speed so that Earth's curvature falls away at the same rate as the spacecraft falls.
- Circular orbital speed in LEO is roughly 7.8 km per second, although the rocket must provide additional velocity to overcome gravity and atmospheric drag.
- Precise guidance is essential: too little energy causes re-entry, while incorrect direction or excess energy can place the payload in an unusable orbit.
- Orbital success therefore tests propulsion, staging, structures, navigation, control, thermal protection, tracking, range safety, payload separation and upper-stage precision together.

## 5. Vikram-1 Engineering & Technology

### 5.1 Four-stage architecture

- The first three stages use solid propulsion and the upper stage uses a liquid engine.
- Staging improves performance because empty tanks, motor casings and engines are discarded after use; the remaining vehicle no longer accelerates dead mass.
- Lower stages provide the large initial thrust needed to lift the rocket through the dense atmosphere.
- The upper stage performs the more delicate task of achieving the required velocity and accurate orbit.

### 5.2 Kalam solid motors

- Skyroot's lower-stage solid motors belong to the Kalam series, named after Dr A. P. J. Abdul Kalam.
- Solid motors store fuel and oxidiser together in a solid grain. They are mechanically simpler, compact, high-thrust and suitable for rapid launch preparation.
- Their main limitation is lower control after ignition: throttling, stopping and restarting are

usually more difficult than with liquid engines.

- ISRO reported that the Kalam-1200 first-stage motor is about 11 metres long, 1.7 metres in diameter and contains about 30 tonnes of solid propellant; it was successfully static-tested at Sriharikota in August 2025.

### 5.3 Raman-I liquid upper-stage engine

- The liquid-fuelled Raman-I engine performs upper-stage work where accurate thrust control and orbital insertion matter most.
- Liquid engines feed fuel and oxidiser separately and permit finer control than a conventional solid motor; this is useful for correcting the trajectory and placing payloads accurately.
- Raman-I uses additive manufacturing, commonly called 3D printing, to consolidate complex engine parts.
- Additive manufacturing can reduce part count, joints, assembly work, material waste and production time. It also permits internal shapes that are difficult to make with conventional machining.
- It does not remove the need for rigorous quality assurance; hidden defects, surface finish, repeatability and material qualification are critical in a rocket engine.
- ISRO states that Raman-I was tested at the Liquid Propulsion Systems Centre facility before the mission.

### 5.4 All-carbon-composite structure

- Vikram-1 makes extensive use of carbon-fibre composite structures instead of relying only on heavier metallic alloys.
- Carbon composites have a high strength-to-weight and stiffness-to-weight ratio; reducing structural mass can increase the share of vehicle mass available for propellant or payload.
- Composites also offer corrosion resistance and allow integrated shapes, but require specialised manufacturing, non-destructive inspection and careful control of impact, delamination and thermal loads.

## 8. ISRO and IN-SPACe Support Behind the Private Mission

- The mission was privately developed and operated, but it was not institutionally isolated from the public space programme.
- ISRO provided access to solid-motor casting and static-test facilities at SDSC, Sriharikota.
- The first-stage solid motor was cast and tested at SDSC; the second-stage motor was also validated at its static-test facility.
- The Raman-I upper-stage liquid engine was tested at an ISRO Liquid Propulsion Systems Centre facility.
- During pre-launch operations, ISRO supported stage preparation, material handling, transport to the launch pad, trajectory analysis and vehicle integration.
- ISRO's safety team maintained round-the-clock oversight at the launch centre.
- IN-SPACe facilitated access to facilities, technical consultancy, mission-readiness reviews and launch clearances.
- This arrangement illustrates a whole-of-ecosystem model: public infrastructure and accumulated expertise reduce entry barriers, while a startup supplies capital, design speed and commercial focus.

## 9. Significance for India

- Reform validation: It demonstrates a concrete outcome of the 2020 decision to open India's space sector more widely to private participation.
- Commercial capability: India now has an additional domestic pathway for launching small satellites rather than depending only on government launch vehicles or foreign services.
- Dedicated small-satellite service: A small launcher can offer customers greater control over launch date and target orbit than a secondary rideshare payload, though cost per kilogram can differ.
- Industrial deepening: Demand can spread to composites, precision manufacturing, avionics, electronics, propulsion, testing, software, insurance and ground services.
- Innovation: The flight combines carbon composites, solid motors and a 3D-printed liquid engine in an Indian privately developed orbital system.
- Strategic autonomy: Multiple domestic launch providers can strengthen resilience, responsive access to space and continuity during supply-chain or geopolitical disruptions.
- ISRO mission focus: As industry handles more routine and commercial work, ISRO can devote a larger share of attention to advanced research, deep-space exploration, human spaceflight and next-generation technology.
- Skilled employment: A growing launch market can create high-value work for engineers, scientists, technicians and specialised suppliers.

- Global positioning: The launch improves India's credibility in the international small-satellite and space-technology market.
- Government/Drishti framing describes India as the third country after the United States and China where a private company independently reached orbit. In answers, attribute this formulation because international comparisons vary according to ownership, launch territory and the definition of 'private'.

## 10. Indian Space Policy 2023

- The policy provides an overarching framework for a competitive national space ecosystem and permits Non-Government Entities to participate across the space value chain.
- Private participation can extend to communication, remote sensing, navigation, satellite and payload building, launch vehicles, launch infrastructure, ground facilities, data and downstream applications, subject to authorisation.
- The policy separates major institutional functions so that research, authorisation, promotion and commercialisation do not remain concentrated in one agency.

## 11. Commercial Space Economy: Why Small Launchers Matter

- Small satellites have shorter development cycles and serve Earth observation, communication, weather, research, Internet-of-Things links and technology demonstration.
- A dedicated small launcher can reduce the need to wait for spare capacity on a larger rocket.
- Customers may select a more suitable orbit and launch window, improving mission flexibility.
- Frequent small launches can support constellation replenishment and replacement of failed spacecraft.
- However, larger rockets carrying many satellites together can have lower cost per kilogram; small launchers compete through responsiveness, schedule control and tailored orbit rather than mass efficiency alone.
- Launch services are only one segment. Much of the space economy comes from satellite communication, navigation, Earth-observation data, user equipment, analytics and downstream applications.
- India must therefore connect launch capability with a domestic market for geospatial services, climate tools, agriculture, logistics, telecommunications, disaster response and defence.

## 12. Challenges Before India's Private Space Sector

- Launch-site bottleneck: Commercial missions still depend heavily on Satish Dhawan Space Centre, constraining independent scheduling and launch frequency.
- Reusable-launch gap: Indian private orbital vehicles are expendable, while reusable systems abroad have altered global launch economics.
- Legislative uncertainty: Indian Space Policy 2023 is an important framework, but absence of a comprehensive Space Activities Act leaves questions about liability, insurance, IP and dispute settlement.
- Anchor-customer deficit: Startups need predictable Government procurement of launches, Earth-observation data and other services to move from prototype to scale.
- Import dependence: Radiation-hardened electronics, high-end semiconductors, sensors and specialised propulsion components remain exposed to export controls and supply disruptions.
- Capital intensity: Launch-vehicle development requires long testing cycles, high upfront investment and tolerance for technical failure.
- Reliability and insurance: A short flight record can increase perceived risk, insurance cost and customer hesitation.

## Conclusion

Vikram-1 is a watershed because it translates India's private-space reforms into a successful orbital mission. Its carbon-composite structure, solid Kalam stages and 3D-printed Raman-I engine show growing industrial capability, while ISRO and IN-SPACe support demonstrate that strong public institutions remain central to private success. India's next goal must be repeatable launches, global customers and domestic supply chains backed by clear law, anchor procurement, additional infrastructure, cyber protection and responsible management of space debris.

## UPSC Civil Services Questions

### Prelims Practice Question

Question With reference to Vikram-1, consider the following statements:
1. It is a four-stage launch vehicle with three solid stages and a liquid upper stage.
2. Its predecessor Vikram-S placed three satellites in Low Earth Orbit.
3. IN-SPACe facilitates authorisation of private space activities in India.

**Which of the statements given above are correct?**

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

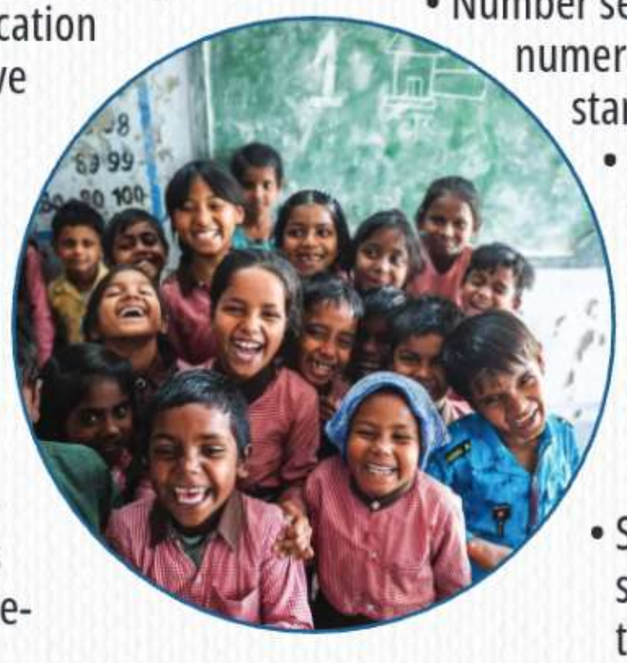
**Answer: (b) 1 and 3 only.**

# NIPUN BHARAT MISSION & FOUNDATIONAL LEARNING

## 1. Why in News?

- Five years after NIPUN Bharat was launched in July 2021, policy discussion has shifted towards consolidating gains, correcting uneven implementation and deciding whether structured support should continue beyond Grade 3.
- The Mission's national deadline is 2026–27. It seeks the required competencies in reading, writing and numeracy by the end of Grade 3, and not later than Grade 5.
- NEP 2020 treated FLN as the highest priority of school education because more than five crore elementary-level children were estimated to lack basic reading and numeracy skills.
- The debate is closely linked with Viksit Bharat: weak foundational learning lowers later academic achievement, employability, productivity, civic participation and inter-generational mobility.

| Dimension | Civil Service examination point |
|---|---|
| Full form | National Initiative for Proficiency in Reading with Understanding and Numeracy |
| Launch | 5 July 2021 |
| Nodal Ministry | Ministry of Education; Department of School Education and Literacy |
| Umbrella scheme | Samagra Shiksha, a Centrally Sponsored Scheme |
| Target | Universal FLN by the end of Grade 3 by 2026–27; desired competency not later than Grade 5 |
| Primary age group | 3–9 years, covering three years of pre-school/Balvatika and Grades 1–3 |
| Mode | Mission-mode implementation through existing national, State, district, block/cluster and school structures |
| Central idea | Holistic, integrated, inclusive, enjoyable and engaging learning |



## 2. Foundational Literacy & Numeracy (FLN)

### 2.1 Components of Foundational Literacy

- Oral language development: listening comprehension, vocabulary, conversation and the ability to express ideas.
- Decoding: understanding the relationship between written symbols or aksharas and their sounds.
- Reading fluency: reading accurately, at an appropriate speed and with expression.
- Reading comprehension: constructing meaning, retrieving information, interpreting a text and thinking about it.
- Writing: forming letters and words and gradually writing meaningful sentences for expression.

### 2.2 Components of Foundational Numeracy

- Pre-number concepts, classification, comparison, patterns and sequencing.
- Number sense: counting, recognising numerals, place value and understanding the number system.
- Operations: addition, subtraction and later multiplication and division in meaningful situations.
- Measurement: length, weight, capacity, time and money in daily life.
- Shapes and spatial understanding: position, direction, geometry and visual reasoning.
- Data handling: reading, organising and interpreting simple information.

### 2.3 Why Grade 3 is the critical point

- Up to Grade 3, children largely 'learn to read'; thereafter they must 'read to learn'. A child who has not acquired FLN faces increasing difficulty in every subject.
- Learning gaps are cumulative. Missing number sense or decoding skills early makes later mathematics, science, social science and language learning progressively harder.
- FLN is therefore a gateway capability—not merely another learning outcome.

## 3.1 Vision

- Create an enabling environment in which every child acquires the desired reading, writing and numeracy competencies by the end of Grade 3.
- Prevent children from being promoted through grades without essential learning capabilities.
- Build the foundation for higher-order learning, life skills, future employment and active citizenship.

## 3.2 Major Objectives

- Ensure an inclusive classroom through play, discovery, activity and links with children's daily lives.
- Formally include home and mother languages in the learning process.
- Develop motivated, independent and engaged readers and writers who read with comprehension.
- Build reasoning in number, measurement, shapes, spatial understanding and everyday problem-solving.
- Provide high-quality, culturally responsive teaching-learning materials in familiar languages.
- Continuously build the capacity of teachers, head teachers, mentors, resource persons and administrators.
- Engage teachers, parents, students, communities, local bodies and policymakers.
- Use assessment 'as learning', 'for learning' and 'of learning' through portfolios, projects, games, quizzes, oral work and short tests.
- Track the learning level of every child and provide timely support.

## 4. Assessment & Monitoring

- Classroom assessment should be continuous, competency-based and low-stakes. Its immediate purpose is to identify what a child can do, locate gaps and modify teaching.
- Multiple techniques are encouraged: observation, portfolios, oral presentation, group work, projects, games, quizzes and short written tasks.
- Child-wise tracking is important because class averages can hide children who are

far behind.
- Foundational Learning Study (FLS), PARAKH Rashtriya Sarvekshan, State surveys and school-based assessments serve different purposes; excessive duplication can burden teachers and produce incomparable data.
- Good monitoring must connect data with action: diagnostic evidence ➜ targeted teaching ➜ mentoring ➜ reassessment ➜remedial support.

## 5. Progress and Present Status

### 5.1 Signs of improvement

- The ASER 2024 evidence cited in the source shows that the share of Grade 3 children in government schools who could read a Grade 2-level text rose from 16.3% in 2022 to 23.4% in 2024.
- NITI Aayog's 2026 school-education review notes recovery in learning outcomes after the pandemic, supported by NEP 2020, NIPUN Bharat and Samagra Shiksha, while stressing that quality and equity gaps remain.
- FLN has moved from a general aspiration to a measurable mission with grade-wise Lakshyas, teacher modules, structured materials, digital resources and institutional monitoring.
- Several States have adapted NIPUN to local languages and administrative systems, demonstrating the value of decentralised implementation within a common national framework.

### 5.2 Why the goal is still difficult

- Progress remains slow relative to the universal target. Even after improvement, a large majority of Grade 3 children are unable to read a Grade 2 text.
- The source estimates learning poverty in India at around 55%, using the World Bank concept of inability to read and understand a simple text by age 10.
- Numeracy generally trails literacy. Weak conceptual teaching, insufficient practice and the cumulative nature of mathematics deepen gaps.
- National averages hide large differences by State, district, gender, disability, social group, household wealth, school type and language background.
- COVID-19 caused learning loss, reduced school readiness and widened inequality in access to learning support.

## 6. Challenges

- Uneven school readiness: Many children enter Grade 1 without quality pre-school experience, oral-language development

or familiarity with structured play.
- Balvatika gaps: Pre-primary access, trained educators, age-appropriate rooms and materials are not yet universal.
- Teacher shortage and deployment: Single-teacher schools, vacancies and non-teaching duties constrain individual attention.
- Multi-grade, multi-level classrooms: Nearly 70% of primary schools are described in the source as MGML settings, but many teachers are not continuously supported for this reality.
- Cascade-training weakness: One-time training can lose quality as it travels through administrative layers and may not change classroom practice.
- Mentoring deficit: Inspections often focus on compliance rather than observation, demonstration and constructive academic feedback.
- Language mismatch: A child's home language may differ from the school language; abrupt transitions can obstruct comprehension.
- Digital divide: DIKSHA expands access to content but cannot substitute for devices, connectivity, teacher mediation and classroom interaction.
- Assessment fragmentation: Multiple tests with different frameworks can generate confusion, duplication and data that are not comparable.
- Data-quality and incentive risks: High-stakes 'NIPUN school' labels may encourage teaching to the test or inflated reporting unless independent checks and safeguards exist.
- Equity barriers: Poverty, malnutrition, disability, migration, seasonal work, gender norms and weak home support affect attendance and learning.
- Grade 3 cliff: Children who miss the target may move to higher grades without a structured bridge, causing learning deficits to compound.

## Conclusion

NIPUN Bharat has made foundational learning the organising principle of school reform, which is essential because enrolment without learning cannot create equal opportunity or a skilled population. India must now move from mission design to classroom depth—universal Balvatika, capable and continuously mentored teachers, multilingual and inclusive pedagogy, coherent assessment, honest district-level accountability and support up to Grade 5. Strong FLN is not only an education goal; it is the first building block of human development and Viksit Bharat.

## UPSC Civil Services Prelims PYQ

### Previous Year Question (2012)

**Which of the following provisions of the Constitution of India have a bearing on Education?**

1. Directive Principles of State Policy
2. Rural and Urban Local Bodies
3. Fifth Schedule
4. Sixth Schedule
5. Seventh Schedule

**Select the correct answer using the code given below:**

(a) 1 and 2 only
(b) 3, 4 and 5 only
(c) 1, 2 and 5 only
(d) 1, 2, 3, 4 and 5

**Answer: (d) 1, 2, 3, 4 and 5.**

# CENTRE PROPOSES BAN ON PARAQUAT DICHLORIDE


## 1. Why in News?

- The Central Government issued a draft notification proposing nationwide prohibition of the import, manufacture, sale, transport, distribution and use of Paraquat Dichloride.
- The proposal was initiated under Section 27 of the Insecticides Act, 1968 after the government concluded that continued use poses serious risks to humans and animals.
- A government-appointed Expert Committee and the Registration Committee recorded adverse health effects, repeated poisoning incidents with high fatality, absence of a specific antidote and extensive international restrictions.
- The action also responds to concerns raised by States including Telangana, Andhra Pradesh, Odisha and Kerala, which sought tighter control.


### 2. Paraquat Dichloride: Basic Facts

| Feature | Civil Service examination point |
|---|---|
| Category | Synthetic, non-selective, fast-acting contact herbicide or weedicide |
| Chemical family | Bipyridyl / dipyridylium compound |
| Function | Kills green plant tissue that it contacts by disrupting photosynthesis and cell membranes |
| Agricultural uses | Weed control; crop desiccation or drying before harvest; sometimes defoliation or plant-growth regulation |
| Crops cited in India | Tea, cotton, coffee, rubber, paddy, wheat, maize, potato, grapes and apple |
| Movement in plant | Acts mainly on contacted tissue; rapid injury limits movement through the whole plant |
| Soil behaviour | Strongly binds to soil particles and generally has little continuing herbicidal activity in soil, but runoff and contaminated sediment still require attention |

## 3. How Paraquat Works

- Foliage rapidly absorbs paraquat. In the presence of light, it diverts electrons during photosynthesis and generates reactive oxygen species.
- These reactive molecules damage cell membranes, cause leakage and rapidly dry or 'burn down' green tissue.
- Because it is non-selective, spray drift can damage any exposed crop or vegetation; careful application is essential.
- Its quick action is useful against weeds, but the same redox activity contributes to severe toxicity in living tissues.

## 4. Health Concerns

### 4.1 Routes of exposure

- Ingestion—most dangerous and a major route in accidental and intentional poisoning.
- Skin contact—risk rises with concentrated product, prolonged contact or damaged skin.
- Eye contact—may cause serious corrosive injury.
- Inhalation of spray or droplets—can irritate and contribute to systemic exposure, especially without protective equipment.

## 5. Why the Government Considered Prohibition Necessary

- **High acute toxicity:** Paraquat is among the world's most toxic herbicides, with a narrow margin between exposure and severe injury.
- **No specific antidote:** Treatment is supportive and outcomes may remain poor after substantial ingestion.
- Repeated poisoning incidents: Documented cases include occupational exposure, accidental ingestion and intentional self-harm, often with high fatality.
- **Occupational vulnerability:** Farmers, agricultural labourers, mixers, loaders, sprayers and persons re-entering treated fields face exposure risk.
- **Misuse and off-label use:** Use beyond approved crops or label directions weakens risk controls and makes residue management difficult.
- **Food-chain concern:** Improper use, especially near harvest, can create residue risks and undermine consumer confidence.
- **International practice:** The chemical has been banned or severely restricted in more than 70 countries, strengthening the case for precautionary review.
- **State pressure**: Several States sought stronger controls based on local poisoning and enforcement experience.

## 6. Legal and Institutional Framework

### 6.1 Insecticides Act, 1968

- The Act regulates import, manufacture, sale, transport, distribution and use of insecticides/pesticides with the objective of preventing risk to human beings and animals.
- Section 9 provides for registration through the Registration Committee.
- Sections 17 and 18 prohibit import, manufacture, sale, stocking, distribu-

tion, transport or use of specified unregistered, misbranded, prohibited or non-compliant insecticides.
- Section 26 enables notification and reporting of poisoning occurrences.
- Section 27 concerns prohibition for reasons of public safety.

## 7. Agricultural and Economic Implications

### 7.1 Likely short-term costs

- Farmers dependent on paraquat may face higher weed-management and labour costs.
- Tea, plantation, orchard, cotton and field-crop systems may need new chemical programmes or non-chemical practices.
- A sudden transition can cause supply gaps, illegal sales, counterfeit products or substitution with another hazardous chemical.
- Small and marginal farmers may require extension support, demonstrations and temporary financial assistance.

### 7.2 Expected benefits

- Lower risk of fatal poisoning, occupational injury and household exposure.
- Reduced public-health expenditure and fewer losses of life and livelihood.
- Better food-safety assurance and potentially improved acceptability of agricultural exports.
- Incentive for integrated weed management, mechanisation, precision application and safer innovation.
- Stronger regulatory credibility and alignment with sustainable agriculture.

## 8. Environmental Significance

- A non-selective herbicide can harm non-target vegetation through drift, reducing habitat and ecological diversity at field margins.
- Runoff, erosion of contaminated soil particles and improper disposal may expose aquatic and terrestrial organisms.
- Frequent herbicide dependence can simplify agro-ecosystems and encourage selection of herbicide-resistant weeds.
- Risk depends on dose, formulation, route, timing, soil characteristics and application practice; environmental policy should be evidence-based and location-specific.
- The decision reflects the precautionary principle: where credible risks are severe and irreversible, lack of complete certainty should not postpone proportionate protective action.

## 9. Safer Transition & Alternatives

### 9.1 Integrated Weed Management (IWM)

- Preventive measures: clean seed, clean machinery, field sanitation and control before weed seed formation.
- Cultural measures: crop rotation, competitive varieties, optimum spacing, timely sowing, cover crops and mulching.
- Mechanical measures: hand weeding, hoeing, mowing, brush cutters and suitable mechanised weeders.
- Physical measures: stale seedbed, solarisation or targeted thermal methods where appropriate.
- Biological and ecological measures: cover-crop suppression and locally validated biological options.
- Chemical substitution: only registered, crop-specific lower-risk herbicides used at label dose, timing and protective conditions.
- Precision methods: shielded sprayers, spot application and decision support to minimise chemical quantity and drift.

### 9.2 Principles for choosing substitutes

- Avoid regrettable substitution—replacing paraquat with another chemical having similar or different serious hazards.
- Evaluate toxicity, persistence, residue profile, groundwater risk, biodiversity effect, resistance risk, cost and local agronomic effectiveness.
- Use public extension trials and transparent recommendations rather than relying only on manufacturer marketing.

## 10. Implementation Challenges

- Existing stocks: Rules are needed for recall, return, compensation and safe destruction.
- Illegal market: Border and e-commerce surveillance, dealer inspections and traceability must be strengthened.
- Farmer awareness: Instructions should be available in local languages through Krishi Vigyan Kendras, extension staff, cooperatives and FPOs.
- Enforcement capacity: States need trained inspectors, accredited laboratories and adequate sampling budgets.
- Data weakness: Poisoning and residue events are often under-reported; hospital, poison-centre and agriculture databases require coordination.
- Affordability: Safer products and non-chemical methods must be economically accessible to smallholders.
- Transition timing: Crop-season planning is essential so that farmers are not left without validated weed-control options.

## 11. Way Forward

- Finalise regulation through transparent scientific review and stakeholder consultation, while keeping public health central.
- Publish the risk assessment, permitted transition arrangements, stock-disposal protocol and enforcement responsibilities.
- Create a time-bound, crop-wise transition plan with locally tested alternatives and cost estimates.
- Support small farmers through demonstrations, custom-hiring centres, subsidies for mechanical weeders and FPO-based procurement.

## Conclusion

The proposed prohibition of Paraquat Dichloride marks a shift from input-centred agriculture towards risk-aware and human-centred regulation. Given its extreme toxicity, repeated fatal poisoning and absence of an antidote, precautionary action is justified; however, success will depend on a fair transition for farmers, safe disposal of stocks, reliable alternatives, strong State enforcement and transparent monitoring. Public health protection and agricultural productivity must be pursued together through integrated weed management and modern pesticide governance.

## Practice Questions

### Prelims MCQ

**Question**

**With reference to Paraquat Dichloride, consider the following statements:**

**1. It is a selective systemic insecticide.**
**2. It is used for weed control and crop desiccation.**
**3. A specific and widely effective antidote is available for poisoning.**
**4. Section 27 of the Insecticides Act, 1968 deals with public-safety prohibition of insecticides.**

**Which of the statements given above are correct?**

**(a) 1 and 3 only (b) 2 and 4 only (c) 1, 2 and 4 only (d) 2, 3 and 4 only**

**Answer: (b) 2 and 4 only.**

# MODIFIED UDAN SCHEME

## 1. Why in News?

- **The Prime Minister launched the Modified UDAN Scheme at Jodhpur on 4 July 2026 to deepen regional air connectivity and build on the original UDAN programme.**
- **The scheme had been announced in the Union Budget 2025–26 and approved by the Union Cabinet on 25 March 2026.**
- **It moves beyond opening routes by supporting infrastructure, airport operations, airlines, helicopters and indigenous small aircraft.**
- **The reform responds to the weak commercial sustainability of many original UDAN routes after the initial subsidy ended.**

## 2. Modified UDAN: Scheme Profile

- **Full name: Regional Connectivity Scheme – Modified UDAN**
- **UDAN expansion: Ude Desh ka Aam Nagrik**
- **Administrative ministry: Ministry of Civil Aviation**
- **Launch: 4 July 2026, Jodhpur**
- **Implementation period: FY 2026–27 to FY 2035–36**
- **Duration: Ten years**
- **Total outlay: ₹28,840 crore as Government of India budgetary support**
- **Budget vision: Connectivity to 120 new destinations and carriage of four crore passengers over ten years**

## 3. Why Was Modification Necessary?

- The original scheme expanded the aviation map, but several routes stopped when three-year VGF support and route concessions ended.
- Thin passenger demand in smaller markets often needs more time to mature.
- High aviation turbine fuel, aircraft leasing, maintenance and crew costs weaken regional-route economics.
- Small aerodromes have high recurring expenditure but limited landing fees, retail income and passenger revenue.
- Many locations need helicopters or small aircraft because conventional runways are impractical.
- Creating an airport without a viable airline network can produce underused or stranded infrastructure.
- The Modified scheme therefore links capital investment with O&M support, route funding, specialised connectivity and domestic aircraft capacity.

### 3.1 Recent discontinuation concerns

- The Drishti article notes that 327 of 663 routes launched since 2017 had fallen into disuse by February 2026.
- It also reports that 15 of 95 revived airports had ceased operations.
- These figures show that route opening is an output; reliable service after subsidy is the more important outcome.

## 4. Component One: Development of Aerodromes

- **Target:** Develop 100 airports from existing unserved airstrips
- **Outlay:** ₹12,159 crore
- **Period:** Eight years
- The component will extend aviation infrastructure to smaller towns and remote regions.
- Projects are intended to be selected and developed under Challenge Mode, encouraging timely execution, quality, innovation and sustainability.
- Existing airstrips can reduce land acquisition and construction time, but each site still requires demand, safety, environmental and lifecycle-cost assessment.
- Development may cover runway, terminal, air traffic services, security, fire services, navigation aids and connectivity to the surrounding region.

## 5. Component Two: Operation and Maintenance Support

- Coverage: RCS-only airports, heliports and water aerodromes with high recurring costs and limited revenue
- Support period: Three years
- Airport cap: ₹3.06 crore per airport per year
- Heliport/water-aerodrome cap: ₹0.90 crore per facility per year
- Estimated outlay: ₹2,577 crore
- Expected reach: Around 441 aerodromes
- The objective is to prevent newly connected facilities from closing merely because passenger and non-aeronautical revenues are initially low.

- O&M support may cover essential functions such as safety, fire services, security, equipment upkeep, utilities and staffing, subject to scheme rules.
- Support should be linked to service standards, traffic development and transparent cost reporting.

## 6. Component Three: Modern Helipads

- Target: 200 modern helipads
- Estimated unit cost: ₹15 crore
- Component outlay:₹3,661 crore, inflation-adjusted
- Period: Eight years
- Priority areas: Hilly, remote, island, aspirational and difficult regions
- Helicopters require less land than fixed-wing airports and can cross mountains, rivers and difficult terrain.
- They can improve medical evacuation, disaster response, administrative access, tourism and last-mile connectivity.
- Helipad development must include obstacle assessment, weather services, lighting where required, fire response, security and safe access.
- Demand and operating feasibility must be tested so that helipads do not remain unused.

## 7. Original UDAN Scheme: Background

- Policy origin: National Civil Aviation Policy, 2016
- Launch: October 2016
- First flight: Shimla–Delhi sector, 27 April 2017
- Implementing agency: Airports Authority of India
- Primary objective: Make regional air travel affordable and connect unserved and underserved regions
- The scheme is demand-driven: airlines identify routes and bid for VGF and other support.
- Selected airlines reserve a prescribed share of seats at an indexed RCS fare and may sell remaining seats at market fares.
- The original scheme offered VGF for a limited concession period, normally three years.
- Airport and State concessions reduce airline operating costs.
- Unserved airport: An airport without scheduled commercial operations during the prescribed reference period
- Underserved airport: An airport with not more than seven scheduled commercial departures per week under the original definition

**Key Parameters of the Regional Connectivity Scheme**

**MODIFIED UDAN**

- Duration: **10 years**
- Implementation Period: **FY 2026–27** to **FY 2035–36**
- Total Outlay: **₹28,840 crore**

Source: Ministry of Civil Aviation

## 8. How the Original Funding Model Worked

### 8.1 Regional Air Connectivity Fund

- The Regional Air Connectivity Fund was created to finance VGF for regional routes.
- A levy on eligible scheduled domestic departures contributed to the Fund; the CAG recorded a ₹5,000-per-flight levy from September 2017, with specified exemptions.
- The Regional Air Connectivity Fund Trust manages the dedicated fund.
- VGF was shared between the Union and States in an 80:20 ratio.
- For North-Eastern States and Union Territories, the ratio was 90:10.

### 8.2 Cost-reducing concessions

- States reduced VAT on aviation turbine fuel at RCS airports, supplied land where required and supported utilities, fire and security services.
- Airport operators waived or reduced specified landing, parking and navigation charges.
- The Union provided tax and policy concessions subject to applicable rules.
- These concessions matter because VGF alone cannot correct every structural cost disadvantage.

## 9. Achievements of UDAN

- India's operational airports increased from 74 in 2014 to 165 by 15 July 2026.
- As of 15 July 2026, UDAN had operationalised 679 routes connecting 95 airports, heliports and water aerodromes.
- More than 3.58 lakh flights had carried over 1.68 crore passengers.
- India emerged as the world's third-largest domestic aviation market.
- Connectivity expanded to remote, hilly and island locations such as Tezpur, Pasighat, Diu, Pithoragarh and Rourkela.
- Shorter travel time improved access to healthcare, administration, education and emergency services.
- Tourism, hospitality, local trade and employment benefited from better mobility.
- Regional airlines and diverse small-aircraft operations received policy support.
- Passenger initiatives such as UDAN Yatri Cafés, Flybrary book access and free Wi-Fi improved travel experience at selected facilities.

## 10. Significance of Modified UDAN

- **Inclusive mobility:** Brings faster transport to citizens outside metropolitan centres.
- **Balanced regional growth:** Connects Tier-2 and Tier-3 cities with markets, investment and employment.
- Tourism multiplier: Supports cultural, ecological, medical and religious destinations.
- **Healthcare access:** Enables faster referrals, specialist travel, organ transport and emergency evacuation.
- **Disaster response:** Helicopters and regional airfields improve access during floods, landslides and earthquakes.
- **North-East integration:** Reduces the cost of distance and terrain in a strategically important region.
- **Aspirational districts:** Improves administrative and economic links in relatively underdeveloped areas.
- **Logistics:** Faster movement of high-value, time-sensitive and perishable goods can support local enterprises.
- **Aerospace industry:** Creates demand for small aircraft, helicopters, MRO, training and components.
- **Cooperative federalism:** Requires Union funding, State concessions, local land and multi-modal access.
- **National integration:** Physical connectivity strengthens people-to-people contact and access to public services.
- **Viksit Bharat 2047:** Builds a more distributed and competitive aviation network.

## 11. Major Challenges

- Thin demand: Small catchment populations may not sustain frequent flights.
- Route discontinuation: Airlines may

withdraw after VGF declines or aircraft are redeployed.
- Airfare affordability: Even capped seats may be costly compared with rail or bus travel.
- High ATF cost: Fuel is a major share of airline expenditure and State taxes vary.
- Small-aircraft shortage: Suitable fleets, pilots, spares and maintenance capacity remain limited.
- Airport under-utilisation: Capital assets can become stranded without airlines and passengers.
- O&M burden: Safety and security costs continue even when traffic is low.
- Weather and terrain: Fog, winds, mountains, monsoon and short runways disrupt operations.

## 12. How Modified UDAN Improves the Earlier Model

- Moves from route-focused intervention to an ecosystem approach covering assets, O&M, airlines and aircraft.
- Extends airline VGF support from the earlier normal three-year period to as much as five years.
- Introduces tapering from year three to encourage a gradual transition towards market viability.
- Retains route exclusivity for only three years, balancing support with later competition.
- Provides explicit O&M aid to RCS-only facilities instead of assuming airport revenue will quickly cover costs.
- Builds a large helipad network for last-mile and emergency connectivity.
- Supports indigenous aircraft acquisition to ease the small-fleet bottleneck.
- Uses Challenge Mode for airport development to focus on timely, high-quality and sustainable projects.

## Conclusion

Modified UDAN is a necessary shift from opening subsidised routes to building a durable regional aviation ecosystem. Its combination of 100 aerodromes, 200 helipads, O&M grants, longer tapered VGF and indigenous aircraft can improve inclusion, emergency access and regional growth. However, its success will depend on realistic demand assessment, safe operations, multi-modal links, transparent fund management and continuity after support declines. The true test is not the number of airports inaugurated, but whether citizens receive affordable and dependable services year after year.

## UPSC Civil Services Previous Year Questions

### Prelims 2024

**Question Consider the following airports:**

**1. Donyi Polo Airport**
**2. Kushinagar International Airport**
**3. Vijayawada International Airport**

**In the recent past, which of the above have been constructed as Greenfield projects?**

**(a) 1 and 2 only**
**(b) 2 and 3 only**
**(c) 1 and 3 only**
**(d) 1, 2 and 3**

**Answer: (a) 1 and 2 only.**

# MOBILE PHONE MANUFACTURING SCHEME (MPMS)

## 1. Why in News?

- **The Union Cabinet approved the Mobile Phone Manufacturing Scheme (MPMS) with a budgetary outlay of ₹62,500 crore.**
- **The scheme aims to consolidate India's mobile phone production success while correcting the next-generation weakness: limited domestic value addition in high-value components, product design, intellectual property and research.**
- **MPMS succeeds the Production Linked Incentive Scheme for Large Scale Electronics Manufacturing (PLI-LSEM), whose tenure ended on 31 March 2026.**
- **The scheme is important for Make in India, Atmanirbhar Bharat, export-led growth, China+1 supply-chain diversification and the Viksit Bharat goal.**

## 2. Objectives of MPMS

- Scale up production: Expand manufacturing capacity and preserve India's momentum as a large global production base.
- Deepen domestic value addition: Increase sourcing of components and sub-assemblies made in India rather than merely assembling imported kits.
- Strengthen supply chains: Build deeper Tier-1 to Tier-4 supplier networks and reduce vulnerability to external shocks.
- Promote exports: Use scale, quality and cost competitiveness to expand India's share in global mobile-phone trade.
- Build Indian brands: Help domestic firms capture value from brand ownership, product definition, distribution and after-sales services.
- Promote design and R&D: Encourage Indian product architecture, engineering, patents, software integration and intellectual property.
- Advance technological sovereignty: Reduce strategic dependence in a critical digital product and create domestic capability for future electronics.
- Generate employment: Create direct factory jobs and indirect employment in components, logistics, testing, repair, packaging and services.

## 4. Why Mobile Manufacturing Matters

- Mobile phones combine electronics, telecommunications, software, industrial design, precision engineering, logistics and consumer branding.
- A large mobile ecosystem can create scale for displays, printed circuit board assemblies, batteries, chargers, camera modules, mechanics, enclosures, connectors, sensors and semiconductor-related activity.
- The sector can anchor electronics clusters and attract global suppliers because phone manufacturing demands quality, speed and large volumes.
- Mobile-phone exports diversify India's export basket beyond traditional petroleum products, gems and jewellery, textiles and agricultural goods.
- Domestic capability is strategically important because smartphones are the primary gateway to digital payments, e-governance, education, health and the platform economy.

## 3. EXPECTED OUTCOMES

| INDICATOR | EXPECTED RESULT DURING SCHEME PERIOD |
|---|---|
| CUMULATIVE MOBILE-PHONE PRODUCTION | Around ₹39 lakh crore |
| DIRECT EMPLOYMENT | About 50,000 jobs |
| EXPORTS | Significant expansion in mobile-phone exports and India's role in electronics global value chains |
| DOMESTIC ECOSYSTEM | Higher local sourcing and stronger component/ sub-assembly supplier network |
| INDIAN FIRMS | Greater support for Indian brands, design, R&D, patents and product ownership |
| GLOBAL POSITION | Consolidation of India as a major manufacturing and export hub |

## 5. Women's Participation and Employment

- Women account for nearly 30% of the total workforce created in India's electronics manufacturing sector over the last decade.
- In mobile-phone manufacturing, women constitute nearly 70% of the direct workforce, making it one of India's most women-intensive manufacturing segments.
- PLI-LSEM generated employment opportunities for around 90,000 women.
- Electronics factories can expand women's formal employment, financial independence and skill acquisition, especially near industrial clusters.

### 5.1 Quality-of-employment concerns

- High female participation must be matched by safe transport, hostels, childcare, sanitation, grievance mechanisms and protection against harassment.
- Policy should monitor wages, contract status, social security, working hours, occupational health and opportunities for technical and supervisory promotion.
- Automation may reduce routine assembly jobs; reskilling women for testing, maintenance, quality control, engineering and management is essential.

## 6. Economic and Strategic Significance

- **Export diversification:** Reduces excessive dependence on a narrow set of traditional export products.
- **Manufacturing share:** Supports the long-standing objective of raising manufacturing's contribution to output and employment.
- **Foreign exchange:** Exports earn foreign exchange, though the net benefit depends on imported component content.
- **Supply-chain resilience:** Diversifies global sourcing away from excessive concentration and provides firms with a China+1 location.
- **Technology spillovers:** Global firms and suppliers can transfer process, quality, logistics and managerial capability.
- **MSME linkages:** Local suppliers can enter packaging, tools, plastics, precision parts, repair and services.
- **Strategic autonomy:** Domestic electronics capability reduces vulnerability in an increasingly digital economy.
- **Regional development:** Well-designed clusters can spread investment, jobs and infrastructure across States.

## 7. Major Challenges

- Import dependence in high-value parts: Chipsets, displays, memory and several precision components remain externally sourced.
- Low R&D intensity: India's strength is stronger in process manufacturing than in global product architecture and patents.
- Weak Indian brands: Domestic firms face powerful global brands, ecosystems, marketing budgets and distribution networks.
- Fiscal cost and additionality: Government must ensure incentives create production that would not otherwise occur and do not become windfall transfers.

## 8. Environmental & Circular-Economy Dimension

- Higher production increases demand for minerals, energy, water, plastics, chemicals and packaging.

- India must integrate MPMS with the E-Waste (Management) Rules, Extended Producer Responsibility, repairability and formal recycling.
- Product design should promote longer life, software support, replaceable parts, recycled materials and easier disassembly.
- Renewable-energy use, water recycling, chemical safety and transparent carbon accounting can improve export competitiveness as global buyers tighten sustainability standards.
- A circular electronics ecosystem can create domestic supply of recovered metals and reduce import dependence.

## Conclusion

MPMS represents India's shift from building assembly scale to capturing higher value in components, design, research, intellectual property and Indian brands. Its production and export potential is substantial, but durable success requires WTO-compatible incentives, transparent performance measurement, deeper supplier networks, skilled and secure employment—especially for women—and environmentally responsible manufacturing. If India converts its vast production base into indigenous capability and global product ownership, mobile manufacturing can become a powerful pillar of Viksit Bharat.

## UPSC Civil Services Prelims PYQ

### Previous Year Question (2019)

With reference to communication technologies, what is/are the difference/differences between LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution)?

1. LTE is commonly marketed as 3G and VoLTE is commonly marketed as advanced 3G.
2. LTE is data-only technology and VoLTE is voice-only technology.

Select the correct answer using the code given below:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

**Answer: (d) Neither 1 nor 2.**

# INDIA'S FIRST GEOTHERMAL WELLS

## 1. Why in News?

- On 17 July 2026, India commissioned its first and deepest two geothermal wells at Puga Valley in the Union Territory of Ladakh.
- The wells were commissioned by the Lieutenant Governor of Ladakh and executed by the ONGC Energy Centre.
- They are an essential step towards the proposed 1 MW pilot plant, expected to become India's first demonstration-scale geothermal power project.
- The development supports India's clean-energy transition and the objective of making Ladakh carbon-neutral.

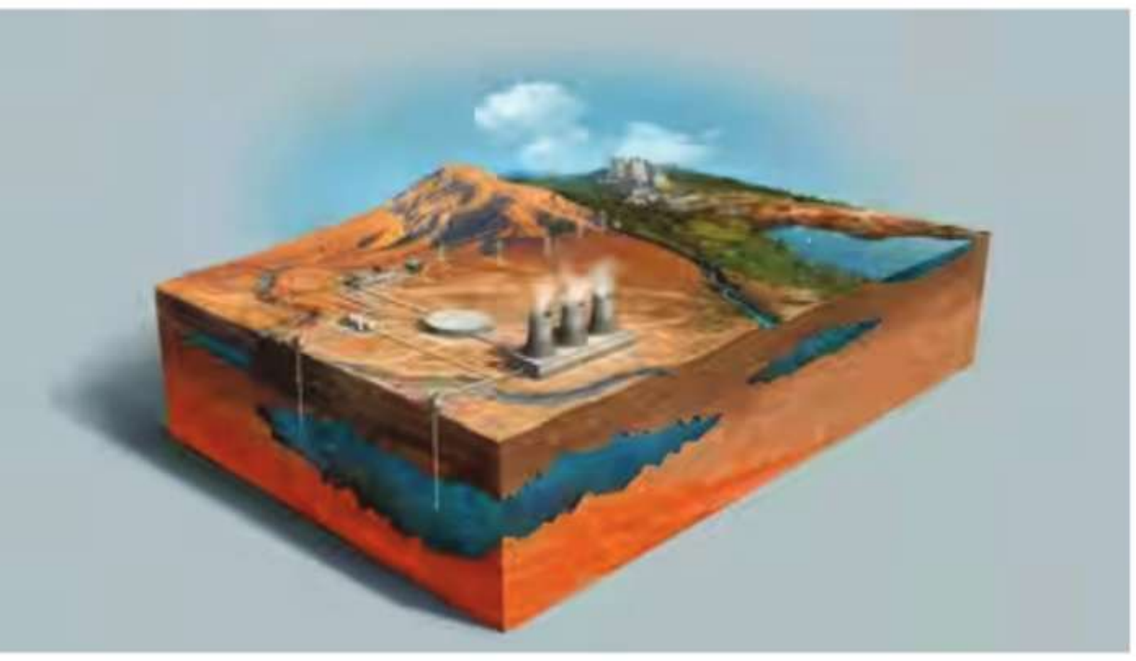
## 2. Project Facts

- **Location:** Puga Valley, south-eastern Changthang region of Ladakh
- **Altitude:** More than 14,000 feet above mean sea level
- **Number of wells:** Two
- **Depth:** 1,000 metres each
- **Recorded temperature:** Maximum 135°C at a depth of 400 metres
- **Proposed capacity:** 1 MW demonstration-scale pilot power plant
- **Executing agency:** ONGC Energy Centre
- **Partners:** Administration of Ladakh and Ladakh Autonomous Hill Development Council, Leh
- **Purpose:** Reservoir evaluation, plant planning, proof of concept and assessment of commercial potential
- **Energy character:** Renewable, domestic and capable of round-the-clock generation
- The first well reached its target depth on 22 May 2026.
- The second well was started on 3 June and completed to 1,000 metres on 8 July 2026.
- Further testing is assessing temperature, fluid flow, pressure, chemistry, permeability and sustainable production.

## 3. Puga Valley: Location

## and Geography

- Puga Valley lies in the Changthang region of south-eastern Ladakh, about 22 km from the Salt Lake Valley.
- Changthang is a high-altitude plateau extending from the Tibetan Plateau into eastern Ladakh.
- The region is cold, arid, sparsely populated and ecologically fragile.



- Puga is known for hot sulphur springs, steam vents, mud pools, mineral deposits and other visible signs of geothermal activity.
- Its geothermal system is associated with active tectonics, deep faults and high heat flow in the Himalayan–Tibetan region.
- Faults and fractures allow underground water to circulate to depth, absorb heat from hot rocks and return towards the surface.
- Puga and nearby Chumathang are among India's most promising high-temperature geothermal locations.

## 4. What Is Geothermal Energy?

- Geothermal energy is heat stored within the Earth's crust and deeper interior.
- The word combines 'geo' meaning Earth and 'thermal' meaning heat.
- The heat comes mainly from residual heat left from the planet's formation and continuing radioactive decay of elements within the Earth.
- The Earth generally becomes hotter with depth; the rate of temperature increase is called the geothermal gradient.
- In areas of high heat flow, faults, volcanic activity or thin crust, usable temperatures may occur at comparatively shallow depths.
- Geothermal resources can generate electricity, supply heat directly and heat or cool buildings through ground-source heat pumps.

## 5. Components of a Geothermal System

- **Heat source:** Hot rocks, magma-related heat or a high regional geothermal gradient
- **Reservoir:** Porous or fractured hot rock that stores and transmits heated fluid
- Fluid: Groundwater or steam that carries heat
- **Permeability:** Connected pores and fractures that permit fluid movement
- **Cap rock:** Low-permeability layer that may help retain hot fluids
- **Production well:** Brings hot fluid or steam to the surface
- **Surface plant:** Converts heat into electricity or transfers it for direct use
- **Reinjection well:** Returns cooled fluid underground to maintain pressure and reduce surface discharge

## 6. How Geothermal Electricity Is Generated

- A production well brings steam or hot water from the geothermal reservoir to the surface.
- Thermal energy is used to rotate a turbine directly or to vaporise a secondary working fluid.
- The turbine drives a generator and produces electricity.
- Steam is condensed and geothermal fluid is preferably reinjected to support reservoir pressure and reduce pollution.

### 6.1 Main plant technologies

- **Dry-steam plant:** Natural steam directly drives a turbine; requires a steam-dominated, high-temperature field
- **Flash-steam plant:** High-pressure hot water partly turns to steam when pressure is reduced; generally used for high-temperature resources
- **Binary-cycle plant:** Geothermal water heats a separate low-boiling fluid through a heat exchanger; the secondary vapour drives the turbine
- **Organic Rankine Cycle:** A common binary system using an organic working fluid suitable for moderate-temperature resources

## 7. Other Uses of Geothermal Heat

- District and space heating in cold regions.
- Ground-source heat pumps for heating and cooling buildings.
- Greenhouse heating and protected cultivation.
- Food, fruit and vegetable drying.
- Aquaculture and fish farming.
- Cold storage and selected industrial processes.
- Bathing, wellness facilities and geo-tourism, subject to ecological safeguards.
- Desalination and deep direct-use heat in suitable projects.
- At Puga, direct heating may offer early benefits to remote communities even if large electricity generation takes time.

## 8. Importance of the Puga Project

- Technology demonstration: Tests drilling, well completion, reservoir behaviour and plant design under Indian conditions.
- Baseload renewable power: Can provide electricity day and night without dependence on sunlight, wind or seasonal river flow.
- Energy security: A local resource can reduce diesel transport and imported-fuel dependence in remote Ladakh.
- Grid stability: Firm generation can balance variable solar and wind power.
- Carbon-neutral Ladakh: Supports a low-carbon development pathway for a cold, high-altitude region.
- Engineering capability: Builds experience in deep drilling, high-temperature materials, geoscience and reservoir management.
- Oil-sector transition: Applies ONGC's drilling and subsurface expertise to a low-carbon energy technology.
- Regional development: Reliable power and heat can support public services, livelihoods, tourism and small enterprises.
- Strategic resilience: Locally available energy is valuable in a border region with difficult logistics.
- National learning: Data from Puga can guide exploration and regulation in other geothermal provinces.

## 9. Advantages of Geothermal Energy

- High capacity-utilisation factor: the National Policy notes that well-managed plants commonly exceed 80%.

- Round-the-clock availability and low weather dependence.
- Small land footprint per unit of dependable electricity compared with many dispersed renewable systems.
- Low lifecycle greenhouse-gas emissions when fluids and gases are properly managed.
- No fuel purchase after development; operating costs mainly involve pumps, maintenance and reservoir management.
- Long plant life is possible with sustainable extraction and reinjection.
- Can provide electricity as well as useful heat, raising total energy efficiency.
- Domestic, decentralised supply can serve remote or electrically isolated communities.
- Existing oil-and-gas skills, equipment, data and wells can be reused.
- Brines may contain valuable minerals such as lithium, silica or borax, subject to environmental safeguards and mineral law.

## 10. Limitations and Environmental Concerns

- Exploration risk: Expensive drilling may find inadequate temperature, flow or permeability.
- High upfront cost: Surveys, deep wells, pipelines and plants require large early investment before revenue begins.
- Site specificity: High-quality electricity resources occur only in favourable geological settings.
- Induced seismicity: Fluid injection or stimulation can alter subsurface pressure and trigger small earthquakes, especially in enhanced systems.
- Reservoir decline: Excessive withdrawal can reduce temperature or pressure.
- Gas emissions: Some fields release hydrogen sulphide or naturally occurring carbon dioxide; capture and monitoring are necessary.
- Brine pollution: Hot fluids may contain salts, arsenic, boron or other minerals and must not contaminate surface or groundwater.
- Subsidence: Large fluid withdrawal without adequate reinjection can cause ground settlement.
- Water requirement: Drilling, cooling and reservoir management may need water in an arid region.
- Corrosion and scaling: Mineral-rich fluids can damage wells, pipes and heat exchangers.
- Biodiversity risk: Roads, drilling pads, noise and waste may disturb fragile high-altitude habitats.
- Community concerns: Projects can affect grazing, cultural landscapes, hot-spring use and local livelihoods.
- Difficult logistics: Puga's altitude, extreme cold, rugged terrain and short working season raise cost and safety risks.
- Transmission challenge: Remote generation needs reliable local demand, storage or grid infrastructure.

## 11. National Policy on Geothermal Energy, 2025

- Notification: 15 September 2025
- Nodal ministry: Ministry of New and Renewable Energy
- Vision: Make geothermal energy a major pillar of India's renewable-energy landscape, energy security and 2070 net-zero pathway

## Conclusion

The Puga wells move India from geothermal assessment towards field-scale demonstration. Their greatest value is the opportunity to test dependable, low-carbon power and direct heat in remote Ladakh while developing national drilling, reservoir and regulatory capability. Yet geothermal energy is not risk-free: high exploration cost, fragile ecology, brine management, induced seismicity and community concerns require careful monitoring. A successful Puga pilot can become a blueprint only if scientific transparency, reinjection, local participation and environmental safeguards remain central.

## UPSC Civil Services Previous Year Question

### Prelims 2013

**Question Consider the following:**

**1. Electromagnetic radiation**
**2. Geothermal energy**
**3. Gravitational force**
**4. Plate movements**
**5. Rotation of the Earth**
**6. Revolution of the Earth**

**Which of the above are responsible for bringing dynamic changes on the surface of the Earth?**

**(a) 1, 2, 3 and 4 only**
**(b) 1, 3, 5 and 6 only**
**(c) 2, 4, 5 and 6 only**
**(d) 1, 2, 3, 4, 5 and 6**

**Answer: (d) 1, 2, 3, 4, 5 and 6.**

# CYCLOSPORIASIS OUTBREAK

## 1. Why in News?

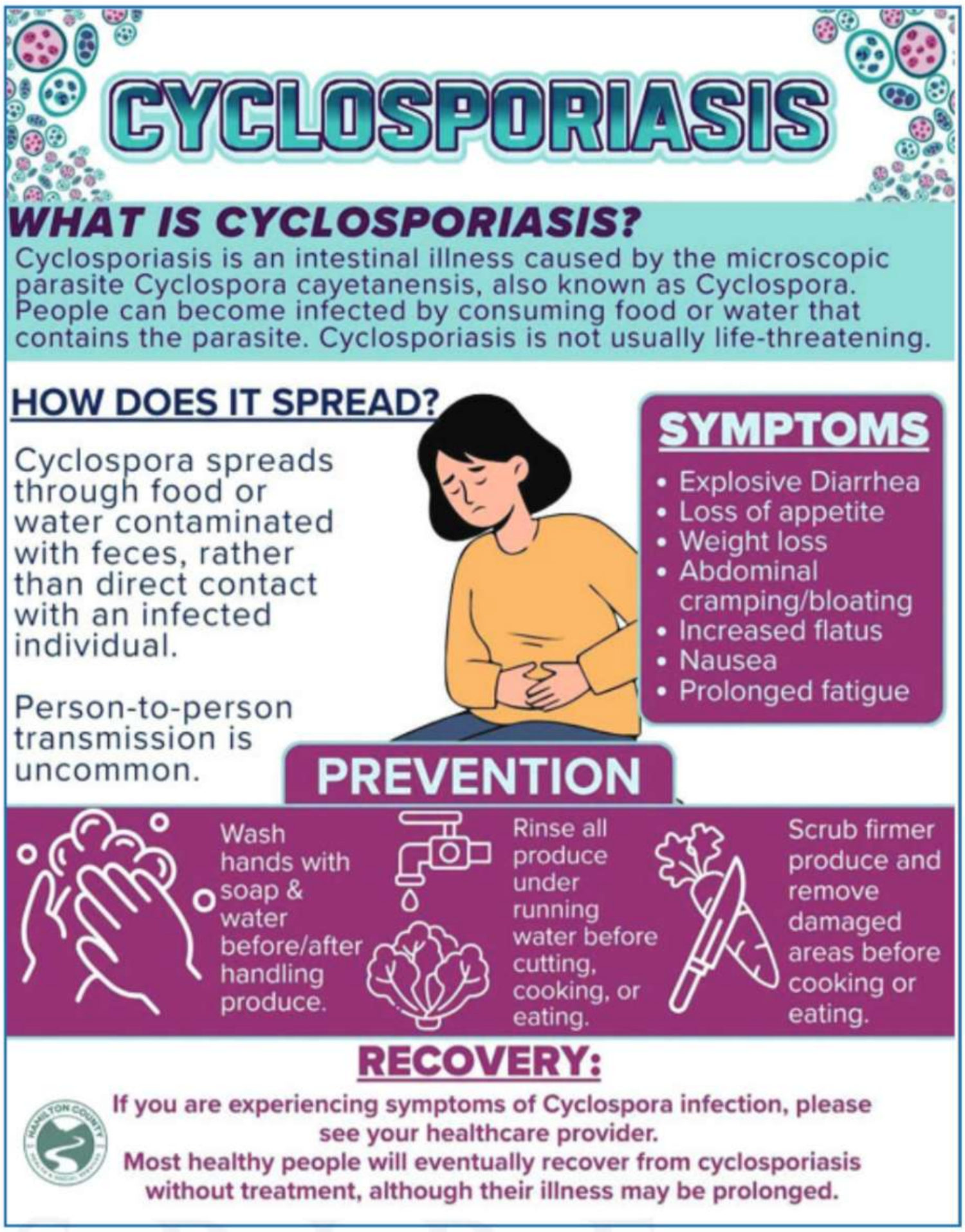
- A widespread surge of cyclosporiasis cases in the United States prompted strict health advisories on consumption of potentially contaminated food and water.
- CDC surveillance showed a sharp seasonal rise in domestically acquired infections across multiple States during the May–August 2026 outbreak season.
- Outbreak investigation focused on contaminated fresh produce and complex distribution chains, illustrating the growing public-health importance of foodborne parasites.
- The topic is relevant to India because tropical climate, raw-produce consumption, sanitation gaps, irrigation-water quality and limited routine testing can favour under-detection.

## 2. Current US Outbreak:

- **Laboratory-confirmed domestically acquired cases:** 4,173
- **Hospitalisations:** 308
- **Deaths:** 0
- **States reporting domestic cases:** 41
- **Age range:** 2–95 years; median age 44
- **Sex distribution:** 56% female
- **Additional cases under investigation:** At least 7,400 reported cases not yet laboratory confirmed
- **Travel-associated cases:** 767 cases; 33 hospitalisations; 0 deaths

## 3. Cyclosporiasis: Core Facts

- **Disease:** Cyclosporiasis—an intestinal, foodborne and waterborne illness
- **Causative organism:** Cyclospora cayetanensis
- **Type of organism:** Microscopic, single-celled protozoan parasite; an apicomplexan coccidian
- **Primary host:** Humans are the only established host for C. cayetanensis
- **Site affected:** Small intestine
- **Infective unit:** Sporulated oocyst
- **Main symptom:** Prolonged watery diarrhoea, sometimes frequent or explosive
- **Geographic pattern:** Worldwide distribution; more common/endemic in tropical and subtropical settings
- **Usual severity:** Often not life-threatening, but can be prolonged and serious in vulnerable persons




## 4. Life Cycle and Why Direct Spread Is Unlikely

- An infected person passes unsporulated oocysts in faeces.
- Freshly passed oocysts are not immediately infectious.
- In the environment, they require time—often roughly one to two weeks under suitable conditions—to sporulate and become infective.
- A person becomes infected after ingesting sporulated oocysts in contaminated food or water.
- The parasite releases infective stages in the small intestine, multiplies in intestinal cells and produces new oocysts that leave through faeces.

## 5. Transmission

### 5.1 Main routes

- Eating raw or undercooked fresh produce contaminated during growing, harvest, washing, packing, transport or food preparation.
- Drinking water contaminated by human faeces or consuming food washed with unsafe water.
- Using contaminated irrigation water, manure or unhygienic handling practices.
- Travel to endemic areas and consumption of untreated water or uncooked produce.

### 5.2 Foods historically linked with outbreaks

- Leafy greens, iceberg lettuce, spinach, basil and cilantro/coriander.

- Raspberries, blackberries and other berries.
- Snow peas, mixed salads and other ready-to-eat fresh produce.
- The source may be difficult to identify because produce from many farms is mixed and distributed across several jurisdictions.

## 6. Symptoms and Clinical Course

- **Incubation period:** Usually about one week; commonly around 2 days to 2 weeks after ingestion
- **Characteristic symptom:** Prolonged watery diarrhoea, often frequent and sometimes explosive
- **Gastrointestinal symptoms:** Abdominal cramps, bloating, increased gas, nausea and sometimes vomiting
- **Systemic symptoms:** Fatigue, loss of appetite, weight loss, muscle aches and low-grade fever
- **Course without treatment:** May persist for days to over a month; symptoms can improve and relapse one or more times
- Asymptomatic infection: Possible, particularly in endemic settings

## 7. Vulnerable Groups

- Immunocompromised persons, including people with HIV/AIDS, cancer treatment, transplantation or immunosuppressive therapy.
- Older adults, who may be more susceptible to dehydration and complications.
- Infants and children, particularly where nutrition and sanitation are poor.
- Travellers from non-endemic areas who have little prior exposure.
- Persons with limited access to safe water, sanitation, timely diagnosis and treatment.

## 8. Complications

- Dehydration and electrolyte imbalance: Result from persistent diarrhoea and can require hospital care.
- Malabsorption: Damage to the intestine can reduce absorption of nutrients, contributing to weight loss and weakness.
- Prolonged or relapsing illness: Symptoms can return after apparent improvement.
- Cholecystitis: Gallbladder inflammation has been reported, particularly in immunocompromised persons.
- Reactive arthritis: Joint inflammation may follow the intestinal infection.
- Rare sequelae: WHO material notes reports of conditions such as Guillain–Barré syndrome and Reiter's syndrome, though these are not the usual presentation.
- Nutrition impact: Repeated or prolonged diarrhoea in children can worsen undernutrition and developmental outcomes.

## 9. Diagnosis and Diagnostic Challenges

- Cyclospora is frequently missed because routine stool testing may not automatically include it and oocyst shedding can be intermittent.


- Several stool specimens collected on different days may be necessary.
- Clinicians should specifically request Cyclospora testing and inform the laboratory about travel and food exposure.

## 10 Prevention

### 10.1 Household and consumer measures

- Wash hands with soap and safe water before preparing food, before eating and after using the toilet.
- Wash fresh produce thoroughly under clean running water and scrub firm produce where appropriate.
- Refrigerate perishable produce promptly and prevent cross-contamination from dirty surfaces or utensils.
- During an identified outbreak, follow health-agency advice; washing may reduce contamination but cannot guarantee complete removal.
- Travellers should prefer safe water and food that is cooked and served hot; avoid questionable raw produce.

### 10.2 Farm-to-fork measures

- Use safe irrigation and produce-washing water and prevent sewage contamination of farms.
- Ensure worker toilets, handwashing facilities, training and paid sick-leave arrangements.
- Apply Good Agricultural Practices, Good Hygienic Practices and HACCP-based controls.
- Maintain traceability from farm, packhouse and distributor to retailer.
- Test water and investigate environmental sources during outbreaks.

## Conclusion

The 2026 cyclosporiasis outbreak shows how a microscopic parasite can exploit gaps across water, farming, food distribution, laboratories and public-health surveillance. Because contaminated produce may look fresh and routine sanitisation may be insufficient, prevention must begin before contamination occurs—through safe water, sanitation, farm hygiene, traceability and rapid detection. For India, strengthening laboratory capacity and integrating health, food-safety, agriculture and municipal systems is essential to control not only Cyclospora but the wider burden of food- and water-borne disease.

## Practice Questions

### Prelims MCQ

**Question With reference to Cyclosporiasis, consider the following statements:**

**1. It is caused by a protozoan parasite.**
**2. Freshly excreted oocysts are immediately infectious, making direct person-to-person spread common.**
**3. Prolonged watery diarrhoea is its characteristic symptom.**
**4. Trimethoprim-sulfamethoxazole is the treatment of choice.**

**Which of the statements given above are correct?**
**(a) 1 and 2 only (b) 1, 3 and 4 only (c) 2, 3 and 4 only (d) 1, 2, 3 and 4**

**Answer: (b) 1, 3 and 4 only.**