THE HINDU

Daily News Analysis

The Hindu Important News Articles & Editorial For UPSC CSE

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Cyclone Ditwah, which moved slowly along the northern Tamil Nadu–Puducherry coast, has weakened into a deep depression but left behind significant human, agricultural, and infrastructural impacts. The event highlights India's disaster preparedness, inter-agency coordination, and the vulnerabilities of coastal districts.

Broken remains: A man standing amid the debris of his collapsed house in T.N. SPECIAL ARRANGEMENT

Cyclone Ditwah weakens; torrential rain claims three lives, damages crops in T.N.

The Hindu Bureau
CHENNAI

Cyclone Ditwah began to weaken on Sunday even as it continued its slow northward movement over the Bay of Bengal, parallel to the coast of northern Tamil Nadu and Puducherry. Torrential rain led to three deaths, with two people killed by collapsing walls in Thanjavur and Thoothukudi districts and one person electrocuted in Mayiladuthurai.

Over 2,300 people were in relief camps on Sunday morning, T.N. Minister for Revenue and Disaster Management K.K.S.S.R. Ramachandran said, adding that 230 huts have been damaged and 56,000 hectares of crops are under water.

The centre of the cyclonic system stayed around 80 km from the coast as it moved at a speed of just 5 kmph on Sunday morning, weakening to a deep depression by Sunday night, according to the Regional Meteorological Centre. It was expected to come within 30 km of the coastline by midnight.

Light rain likely
Light to moderate rain is likely at isolated places over T.N. and Puducherry-Karaikal on Monday, with thunderstorms and lightning at a few places. Heavy rain is likely at isolated places in Tiruvallur district. Gale winds are likely

334 dead, over 300 missing in Sri Lanka

COLOMBO
At least 334 people have died and 370 remain missing as Sri Lanka reels from the impact of Cyclone Ditwah. Huge number of fatalities were reported from Badulla, Kandy, Nuwara Eliya, and Matale districts, home to some of the most economically marginalised communities. » PAGE 14

to decrease gradually, with speeds of 45-55 kmph, gusting to 65 kmph, by Monday morning. Sea conditions are likely to improve gradually.

Addressing a press conference in the State Emergency Operations Centre, Mr. Ramachandran said that due to the heavy rain, crops in about 56,000 hectares in various districts are under water. Crops have been affected in about 24,000 hectares in Nagapattinam district, over 15,000 hectares in Tiruvarur district and about 8,000 hectares in Mayiladuthurai district, he said.

Once the water recedes, officials will calculate the actual damage and Chief Minister M.K. Stalin will decide on announcing compensation for the damages incurred by farmers, the Minister said. In response to a query, he said

compensation could be granted only if the loss of crops was over 33%.

The Air Force moved about 300 National Disaster Response Force (NDRF) personnel from Maharashtra and Gujarat to Chennai. In a social media post, Mr. Stalin said: "An IAF C-17 has airlifted NDRF teams and equipment from Pune and Vadodara to Chennai, enabling rapid deployment of over 300 NDRF personnel and around 35 tonnes of essential gear." With the arrival of 10 additional teams, 38 teams are now ready across Tamil Nadu and will be deployed to areas on the basis of their need, Mr. Ramachandran said.

About 230 huts have been damaged due to the rain, he added. As of Sunday morning, over 2,300 people have been accommodated in a total of 38 relief camps in nine districts of Tamil Nadu – 10 camps in Nagapattinam district, nine in Pudukkottai, seven in Villupuram, four in Tiruvarur, two each in Mayiladuthurai, Ramanathapuram, and Thanjavur, and one each in Chengalpattu and Ranipet.

The State government is coordinating with other government agencies to ensure the safe return of people from the State who are stranded in Sri Lanka, the Minister said. They are expected to reach on Sunday, he added.

Key Analysis

1. Meteorological Behaviour

- The cyclone moved parallel to the coast, remaining ~80 km offshore before weakening.

- By Sunday night, it degraded into a **deep depression**, reducing wind speed to 45–55 km/hr (gusting to 65 km/hr).

- Forecast: light to moderate rainfall in most regions, isolated heavy rain in **Tiruvallur** district.

2. Human Impact

- **Three casualties**:

  o Two deaths due to wall collapse (Thanjavur, Thoothukudi).

  o One due to electrocution (Mayiladuthurai).

- **230 huts damaged** and **2,300+ people** shifted to **38 relief camps** across 9 districts.

Significance:
Loss of life in moderate-severity cyclones reflects structural weaknesses in housing and the need for safer rural infrastructure.

3. Agricultural Losses

- **56,000 hectares** of crops submerged.

  o **Nagapattinam**: ~24,000 ha

  o **Tiruvarur**: ~15,000 ha

  o **Mayiladuthurai**: ~8,000 ha

- Compensation will be announced only after the water recedes and **>33% damage** is verified (as per norms).

4. Government Response & Coordination

- Rapid deployment of **NDRF** from Maharashtra and Gujarat via **IAF C-17 aircraft**.

- With the addition of 10 more teams, **38 NDRF teams** are stationed in Tamil Nadu.

- Relief camps organized with support from multiple government agencies.

- Coordination initiated for the safe return of **Indians stranded in Sri Lanka** due to weather conditions.

5. Broader Implications

- **Climate risks:** Increasing frequency of intense rain events even in weaker cyclones suggests climate variability's growing impact.

- **Infrastructure gaps:** Repeated hut collapses indicate the need for stronger cyclone-resilient housing, especially in coastal rural Tamil Nadu.

- **Disaster readiness:** Early warning and quick mobilization reduced larger casualties, showing improvement in institutional capacity.

Conclusion

Cyclone Ditwah, despite weakening quickly, exposed the structural and agricultural vulnerabilities of Tamil Nadu's coastal districts. At the same time, the coordinated response of the State government, NDRF, and the Air Force reflects India's strengthening disaster management system. For the UPSC context, the event underlines the intersection of climate change, rural infrastructure, and institutional preparedness—key themes for mains answer-writing and disaster-related case studies.

UPSC Prelims Practice Question

Ques: **Consider the following statements regarding tropical cyclones in India:**

1. Cyclones in the Bay of Bengal generally move north-westward and often affect the eastern coast of India.

2. A cyclone can be classified as a "deep depression" if its wind speed falls below 60 km per hour.

3. Crop loss compensation under the National Disaster Response Fund (NDRF) is granted only when crop damage exceeds 33%.

Which of the above statements are correct?

A. 1 and 2 only

B. 2 and 3 only

C. 1 and 3 only

D. 1, 2 and 3

Ans: c)

UPSC Mains Practice Question

Ques: Even weaker cyclones today cause disproportionate damage due to climate-induced extreme rainfall." Analyse with recent examples including Cyclone Ditwah. **(150 Words)**

Daily News Analysis

Page 01 : GS 1 : Geography and Social Issues

A new report titled "Unravelling India's demographic future: Population projections for States and UTs 2021–2051", released by the International Institute of Migration and Development (IIMAD) and the Population Foundation of India (PFI), projects a modest rise in the populations of India's two major island territories — Lakshadweep and the Andaman & Nicobar Islands (A&N) by 2051. This holds relevance for UPSC in the context of demography, regional development, governance of UTs, climate vulnerability, and strategic significance.

Population in A&N, Lakshadweep set to rise: report

The Hindu Bureau
THIRUVANANTHAPURAM

The populations of India's island territories, Lakshadweep Islands and the Andaman and Nicobar Islands, are projected to increase by 9.68% and 5.73% by 2051, according to a new national-level report recently released by the International Institute of Migration and Development (IIMAD) and the Population Foundation of India (PFI).

The population of Lakshadweep, a string of islands in the Arabian sea, is projected to go up from 67,642 in 2016 to 74,194 in 2051.

Likewise, the population of Andaman and Nico-bar Islands in the Bay of Bengal is projected to rise from 3,98,310 to 4,21,135 during the same period, according to the report 'Unravelling India's demographic future: population projections for States and Union Territories 2021-2051.'
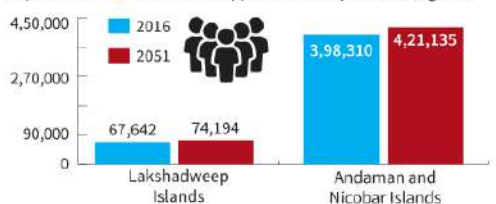
S. Irudaya Rajan, chair of the Kerala-based IIMAD was the principal investigator for the report and J. Retnakumar, the co-principal investigator.

Different approach
The report, which provides a national perspective as well as State and Union Territory (UT)-wise projections, has used a different approach for making projections for the smaller States and Union Territories.

"The decadal growth rates of population in most of the smaller States and the Union Territories are erratic and no clear trend in the growth rates is discernible.

Moreover, the Sample Registration System (SRS) does not consistently provide the essential demographic inputs needed for population projections for these territories," the report notes.

Due to this limitation, the report employs mathematical methods – specifi-cally curve fitting using logistic methods – to project their populations.

Gender-wise projections show that the male population would increase from 34,716 in 2016 to 37,785 in 2051 and the female population from 32,926 to 36,319 in Lakshadweep.

In the case of Andaman and Nicobar Islands, the male population is projected to go up from 2,13,467 in 2016 to 2,26,139 in 2051 and female population from 1,84,843 to 1,94,996.

For arriving at the projections, the report drew on demographic datasets including the Census, SRS, National Family Health Survey, Civil Registration System and the National Sample Survey.

Demographic drift
India's major island groups may see increase in population, says report which used a distinct approach to map smaller regions

- 2016
- 2051

	2016	2051
Lakshadweep Islands	67,642	74,194
Andaman and Nicobar Islands	3,98,310	4,21,135

SOURCE: IIMAD, PFI

Key Analysis

1. Population Projections

- **Lakshadweep**

    o 2016 population: **67,642**

    o 2051 projected population: **74,194**

    o **Growth: 9.68%**

- **Andaman & Nicobar Islands**

o 2016 population: **3,98,310**

o 2051 projected population: **4,21,135**

o **Growth: 5.73%**

2. Gender-Wise Projections

Lakshadweep

- Male: **34,716 → 37,785**

- Female: **32,926 → 36,319**

Andaman & Nicobar

- Male: **2,13,467 → 2,26,139**

- Female: **1,84,843 → 1,94,996**

Significance:
Balanced sex ratios highlight relatively equitable health and social outcomes compared to many mainland Indian states.

3. Methodology and Challenges

The report adopts a **different approach** for smaller States and UTs due to:

- **Erratic decadal growth rates**

- **Inconsistent demographic data** from the Sample Registration System (SRS)

- Small population sizes making conventional projection methods unreliable

Therefore, the study uses:

- **Mathematical curve fitting**,

- **Logistic growth methods** for projections

4. Data Sources Used

To ensure reliability, the projections are built using multiple datasets:

- Census

- Sample Registration System (SRS)

- National Family Health Survey (NFHS)

- Civil Registration System (CRS)

- National Sample Survey (NSS)

5. Broader Implications

a. Ecological and Climatic Concerns

Islands like A&N and Lakshadweep are:

- Environmentally fragile

- Highly vulnerable to **sea-level rise**, coastal erosion, and cyclones

Even modest population growth increases pressure on:

- Water resources

- Coral ecosystems

- Waste management

- Urbanisation in limited land areas

b. Strategic Importance

Both island groups are strategically important:

- Lakshadweep lies close to West Asia and Indian Ocean shipping lanes

- A&N provides strategic oversight of the **Malacca Strait**, crucial for India's maritime security

Population trends must therefore be integrated with:

- Defence infrastructure

- Disaster management

- Sustainable development planning

c. Governance and Service Delivery

Small population increases still require:

- Better connectivity (air/sea)

- Healthcare expansion

- Digital governance

- Education and employment opportunities

Conclusion

The projected population rise in Lakshadweep and the Andaman & Nicobar Islands is modest but significant for ecological sustainability, strategic planning, and demographic governance. The report's methodology highlights the challenges of demographic estimation in small territories. For UPSC aspirants, the issue provides a multidimensional case study that links **demography, environment, national security, and development planning**—all critical themes for GS Mains and essays.

UPSC Prelims Practice Question

Ques : The recent population projection for Lakshadweep and Andaman & Nicobar Islands used logistic curve fitting. This method was used primarily because:

A. The islands have the lowest fertility rates in India.

B. Decadal population data for these islands is erratic and SRS data is inconsistent.

C. Census data for these islands is not collected by the Government of India.

D. These islands have negative population growth.

Ans: b)

UPSC Mains Practice Question

Ques : The projected population rise in India's island territories highlights the need for a balanced approach between development and ecological sustainability. Examine. **(150 words)**

A recent article revisits T. Janakiraman's classic Tamil novel Mogamul, exploring how the narrative uses the sacred spaces of Kumbakonam—particularly the Nageswaran Temple—to highlight the interaction between Carnatic and Hindustani musical traditions. The novel becomes a medium to comment on the evolving aesthetics of Carnatic music and the contrasting emphasis on voice culture in Hindustani music.

An exchange of ideas between Carnatic and Hindustani music

B. Kolappan
CHENNAI

An overwhelming silence prevails in the inner precincts of the Nageswaran Temple, known as *Kudanthai Keezhkottam*, in Kumbakonam in Thanjavur district. Sung in praise by the Saivite saints, the temple, together with the mandapam designed like a chariot, stands testimony to the creative zenith of the early Cholas. For lovers of books and music, however, the temple is inseparable from T. Janakiraman's Tamil novel *Mogamul* (thorn of desire) and the soul-stirring music of the Hindustani performers from Maharashtra.

Janakiraman seems to have chosen the setting with a clear intention. The musicians first appear at the Kumbeshwaran Temple, then at the house of Ranganna, the guru of Babu, the protagonist, and later hold a full-fledged concert at the Nageswaran Temple. The temple's atmosphere is perfectly suited to their performance. Even today, there is little change in the setting.

Highlighting contrast
"A commentary on the difference between idealistic Carnatic music and what was prevalent in concert halls underlines the novel throughout. Janakiraman suggests that the soul of the music, embodied by Ranganna – a character modelled on Umayalpuram Swaminatha Iyer – is being lost, and singers no longer focus on the voice. Conventionally, too, there is an opinion that Carnatic musicians do not pay enough attention to voice culture," says Lalitharam, historian of Carnatic music.

When Babu first listens to the Hindustani musicians at Ranganna's house, he marvels at the sheer weight of the voice: "Can a human voice carry such weight? What strength there is! The effortless control of breath unsettled Babu. How does the entire voice rise to the higher notes? His body trembled as the singer stayed in the *mandhra* for four minutes, then gradually reached the *mel shadjam* and sustained the note with long *karvais*. It gave Babu goosebumps, and his eyes were filled with tears," writes Janakiraman.

"In the Kumbeshwaran Temple, devotees mistook them for beggars and tossed a few coins. They deposited all of it in the temple *hundi*," Ranganna tells Babu.

Driving home the point
Janakiraman creates yet another scene to drive home his point: the entry of Palur Ramu, a disciple of Ranganna, who now resides in Chennai. Draped in a khadi dhoti and *panchakacham* (dhoti traditionally draped with five pleats), he flaunts his patriotism merely borrowed from politicians and mediapersons.

The arrogant smile on Babu's lips fades when the Hindustani musician, at Ranganna's request, holds the *mandra panchamam* and then lowers his voice further to the *mandra shadjam*, revealing the delicate contours of the raga.

When Babu remarks that the Hindustani singers were fortunate, Ranganna makes it clear it was hard work and practice that contributed to the sweetness of their voices.

Later, Babu brings them to the house of Yamuna, the heroine of the novel, as she can converse with them in Marathi and obtain more details of their origin and music. Subsequently, he arranges a performance at the Nageswaran Temple, which resembles a "poor man's wedding ceremony". The sound of the tambura echoes across the granite pillars.

The senior musician aligns himself with the *sruthi* and begins to sing. Yamuna and her mother Parvathi stand near a pillar. After they finish singing, Babu approaches her.

"My heart aches. How is he able to sing like this? I feel I am going mad," says Yamuna.

Setting the stage: Cover of the novel Mogamul by T. Janakiraman; and the Nageswaran Temple. SPECIAL ARRANGEMENT, R. VENGADESH

Key Points and Analysis
1. Cultural Setting: Kumbakonam and the Nageswaran Temple
- The **Nageswaran Temple**, built during the **early Chola period**, forms the atmospheric backdrop.
- Known as Kudanthai Keezhkottam, it is celebrated by **Saivite saints**.
- The mandapam built like a **chariot** represents Chola architectural grandeur.

2. Mogamul and the Symbolism of Music
T. Janakiraman deliberately uses music as the central device:
- The protagonist **Babu**, a disciple of Ranganna, encounters **Hindustani musicians** from Maharashtra.
- Their music is introduced in different sacred spaces — first at the **Kumbeshwaran Temple**, then at **Ranganna's home**, and finally in the **Nageswaran Temple**.

Symbolic meaning: These spatial transitions illustrate the growing emotional and spiritual impact of music on Babu and Yamuna.

3. Carnatic vs Hindustani: Aesthetic Commentary

Historian **Lalitharam** notes that Janakiraman uses the story to critique:

- The decline of idealistic Carnatic music.
- Performers focusing more on performance mechanics than **voice culture**.

In contrast, the Hindustani singers bring:

- Depth and "weight" in voice
- Exceptional breath control
- Long, sustained notes (karvais)
- Mastery over lower registers (mandra sthayi)

4. Voice Culture as a Core Theme

The novel repeatedly emphasises:

- The Hindustani singer's ability to hold **mandra panchamam** and extend to **mel shadjam** effortlessly.
- Babu's emotional response — goosebumps and tears — demonstrates the spiritual power of a refined voice.
- Ranganna (modelled on **Umayalpuram Swaminatha Iyer**) explains that such mastery is due to **hard work**, not luck.

This becomes a subtle critique of contemporary Carnatic performers who, in the author's view, may neglect vocal training.

5. Socio-cultural Commentary

Janakiraman also critiques superficial modernity:

- The entry of **Palur Ramu**, a former student turned Chennai-based artist who flaunts hollow patriotism through attire and rhetoric.
- This contrasts sharply with the sincere artistry of the visiting Hindustani performers.

Interpretation:

The novel comments on authenticity vs performative identity—an enduring theme in Indian cultural discourse.

6. The Climax: Emotional Resonance of Music

At the Nageswaran Temple:

- The concert takes place in a near-empty space that resembles a "poor man's wedding".
- The sound of the **tambura** reverberates through granite pillars.
- Yamuna is deeply moved: "My heart aches… I feel I am going mad."

This depicts music as a transformative force, cutting across linguistic, regional, and classical traditions.

Conclusion

The article and the novel together illustrate the **rich cultural dialogue between Carnatic and Hindustani music**, set against the architectural and spiritual heritage of Kumbakonam's temples. Beyond music, Mogamul offers insights into authenticity, artistic discipline, and the evolving aesthetics of Indian classical traditions.

UPSC Prelims Practice Question

Ques: Which of the following correctly describes a difference highlighted in the article between Carnatic and Hindustani music?

A. Carnatic music uses sruthi while Hindustani music does not.

B. Hindustani music places greater emphasis on voice culture and breath control.

C. Carnatic music has more ragas than Hindustani music.

D. Hindustani music avoids lower registers (mandra sthayi).

Ans: A)

UPSC Mains Practice Question

Ques : Examine the significance of voice culture in Indian classical music. How does the difference in vocal training between Carnatic and Hindustani systems shape their musical expression? **(250 words)**

Page 07 : GS 2 & 3 : Social Justice & Science and Tech

Pancreatic cancer is one of the most lethal malignancies due to its late detection, rapid progression, and high metastatic potential. A key feature of its tumour microenvironment is hypoxia (low oxygen conditions). A recent IIT-Bombay study provides new insights into how hypoxia alters the lipid composition and biophysical properties of cancer cell membranes, ultimately enhancing metastatic behaviour. These findings link cellular biophysics with cancer metastasis.

Daily News Analysis

Hypoxia rewires membrane lipids, drives pancreatic cells to move: IIT-Bombay study

Pancreatic cancer thrives in low oxygen conditions; hypoxia promotes rapid cell division and modifies the lipids present in cancer cells' plasma membrane, which affects how easily they move around; the research could open pathways to preventing excessive migration of pancreatic cancer cells and mitigating metastasis of the tumour

Rohini Subrahmanyam

Pancreatic cancers are aggressive and deadly, with high rates of metastasis and poor prognosis. The tumour environment is also hypoxic: the cells rapidly divide and thrive in very low oxygen conditions.

Now, IIT-Bombay researchers have shown that the hypoxia ends up enhancing the cells' metastatic behaviour. By affecting the cells' plasma membrane lipids, hypoxic conditions can help the cells migrate more.

"The membrane is not just something that is covering the cell and keeping everything that should be inside, inside, and everything that should be outside, outside," said BITS Pilani biophysicist Sudipta Maiti, who wasn't involved in the work. "It is also the cell's window to the outside world."

Stiff yet malleable

In two studies published in 2023 and 2025, IIT-Bombay chemist Shobhna Kapoor and her colleagues showed that hypoxia can modify the kinds of lipids present in the cancer cells' plasma membrane, thus affecting how easily the cells are able to fluidise and move around. In the 2023 *Biochimica et Biophysica Acta* paper, they reported that hypoxia causes the cells of the PANC-1 pancreatic cancer cell line to migrate more. This happened because hypoxia was able to modulate the lipid ratios in the cells: lipids that promote membrane stiffening were pushed towards the cytoplasm and inner organelles. They also observed that the cells had less cortical stiffness, meaning the layer of skeleton just below the membrane allowed for more fluidity.

In the *Journal of Membrane Biology* study published in August, the researchers studied a different cell line called CAPAN-2. In contrast, researchers found that this pancreatic cancer cell line had higher cortical stiffness in response to hypoxia. But it still maintained its malleable nature by adding more membrane components to its plasma membrane. Even the lipidome modifications were different in this case, with some lipids that promote membrane stiffening making their way to the plasma membrane. But the scientists believe that this is a local stiffening effect and doesn't affect the overall membrane properties.

Even though hypoxia affected cell stiffness differently in the two pancreatic cancer cell lines they studied, the cells still modified their own membrane in a way that their migration increased when oxygen was low. Together, the studies could open new pathways that could both contribute to and prevent excessive cell
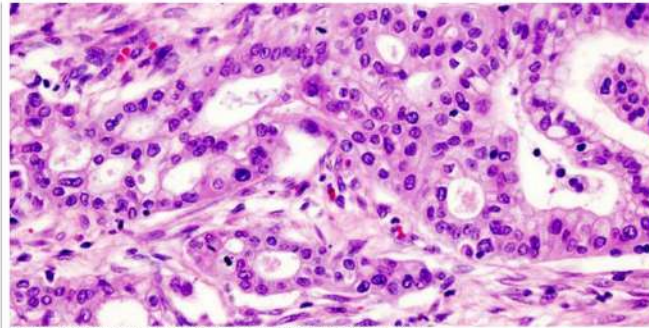
migration in pancreatic cancer cells and modulating them could potentially help mitigate the tumour from metastasising.

In for a surprise

When Dr. Kapoor and her student initially realised that hypoxia caused the PANC-1 cells to migrate faster, they decided to check how the membrane's biophysical properties – like how ordered, fluid or bendy the membrane was – were changing. But they were in for a surprise when they found that some broad properties of the membrane didn't change dramatically.

"Then we decided let us then not look at ensemble properties of the membrane, maybe let us look at the composition of the membrane," Dr. Kapoor said. "And then we realised that actually, the hypoxia is changing the lipidome of the cell."

They found that even though the cell seemed to be increasing its amounts of membrane-stiffening lipids, like lipids with long fatty-acid chains or saturated bonds, the lipids in the plasma membrane didn't change as much.

"There is a feedback loop that is going on which helps the membrane to maintain homeostasis so that the membrane properties remain the same," said Dr. Kapoor. "The changes that the hypoxia brings about in the lipid levels, they get compensated in internal organelles like the nucleus, mitochondria, and endoplasmic reticulum."

They also found that the PANC-1 cells had less cortical stiffness because of low actin volume. With low stiffness and any membrane-stiffening lipids being trafficked inwards, the cell could maintain

❝ Lipid molecules are like tadpoles: it's a little head and a little tail and the whole thing is probably two nanometers long. Solid-state NMR can look at this little tail and see how dynamic it is

DR. SUDIPTA MAITI
BITS PILANI

a malleable membrane that helped it migrate, the researchers speculated.

'Like tadpoles'

The story is slightly different for CAPAN-2. Hypoxia still helped the cells migrate more, but their cortical stiffness was higher in hypoxic conditions. But other experiments revealed that the cell was trafficking more membrane material to the plasma membrane, to counteract this stiffness and likely maintain its migratory behaviour.

The researchers also found an increase in saturated lipids in the plasma membrane, suggesting that the cell may also be trying to locally enhance the membrane stiffness.

"There seems to be some diversity from one cell type to another," said Mohammed Saleem, a biophysicist at the National Institute of Science Education and Research, Bhubaneshwar. "[Some] changes are sensed by the cells, and they try to re-equilibrate so as to counter the changes."

Dr. Maiti said solid-state nuclear

magnetic resonance (NMR) – a technique that uses magnetic fields to look at the atomic level structure and dynamics of solid molecules – could probe deeper into the plasma membrane and figure out how exactly hypoxia could be changing its properties.

"Lipid molecules are like tadpoles: it's a little head and a little tail and the whole thing is probably two nanometers long. Solid-state NMR can look at this little tail and see how dynamic it is," he explained.

"It [can be] fluctuating madly or pretty stable because the lipids are packed, [which] translates into mechanical property – how stiff something is, how loose something is. It'll be nice to show quantitatively, using solid-state NMR, how hypoxia leads to change in this membrane order."

Effects on other cancers

Both Dr. Kapoor and Dr. Saleem said that going forward, one must also explore how hypoxia affects other cancers.

"Each of these cancerous cell types has their own niche and microenvironments," Dr. Saleem said. "It would be interesting how hypoxia and the differences in those microenvironments could come into play to drive the migration."

"A small biochemical reaction [causing hypoxia] can induce a larger physical manipulation of the cell membrane, [helping] the cells migrate faster," Dr. Saleem added. "This could also open up venues for exploring membrane targeted anti-cancer therapeutics."

(Rohini Subrahmanyam is a freelance journalist in Bengaluru.
rob.subb@gmail.com)

Micrograph of pancreatic ductal adenocarcinoma, a common type of pancreatic cancer. KGH (CC BY-SA)

THE GIST

▼ Pancreatic cancers are aggressive and deadly, with high rates of metastasis and poor prognosis. The tumour environment is hypoxic: IIT-Bombay researchers have now shown that the hypoxic environment enhances metastatic behaviour in these cancer cells

▼ Researchers found that even though the cell seemed to be increasing its amounts of membrane-stiffening lipids, the quantity in the plasma membrane didn't change as much. A feedback loop helps the membrane maintain homeostasis so its properties remain the same

▼ The findings on the impact of hypoxia on cell membranes are crucial to the study of other cancerous cell types, which have their own microenvironments. This holds out the possibility of developing anti-cancer therapeutics that target the membrane

Key Analysis

1. Why Hypoxia Matters in Cancer

- Pancreatic tumours grow rapidly but have poor blood supply → **low oxygen zones**.

- Hypoxia typically triggers:

  o rapid cell division

- o metabolic reprogramming

- o increased invasiveness

The new studies show that hypoxia also **modifies cell membrane lipids**, influencing **cell migration**, which is essential for metastasis.

2. Main Findings of the IIT-Bombay Studies

Two papers (2023 and 2025) examined **two pancreatic cancer cell lines** (PANC-1 and CAPAN-2).

A. PANC-1 Cells (Study 1, 2023)

- **Hypoxia → increased migration.**

- Hypoxia altered the ratios of lipids within the cell:

  - o Membrane-stiffening lipids were moved **away from the plasma membrane** (towards inner organelles).

- Result:

  - o **Plasma membrane became more fluid and flexible**, aiding movement.

  - o **Cortical stiffness decreased** due to reduced actin support.

- Overall:
  Lower stiffness + high membrane fluidity → faster migration under hypoxia.

B. CAPAN-2 Cells (Study 2, 2025)

- Migration also increased under hypoxia, but through a different mechanism.

- Here, hypoxia caused:

  - o **Higher cortical stiffness** (opposite of PANC-1).

  - o To compensate, the cell **pushed more membrane components to the plasma membrane**, maintaining flexibility.

  - o Some stiffening lipids increased locally in the plasma membrane, but without affecting overall mobility.

Interpretation:

Different cancers use different biochemical strategies, but hypoxia consistently promotes migration.

3. Why the Membrane Matters

The plasma membrane is not just a protective barrier but acts as:

- a **mechanical regulator** (stiffness/softness affects movement)

- a **communication interface** with the tumour environment

- a **target for cancer therapeutics**

The study shows:

- Hypoxia **reprograms the lipidome** (total lipid composition) via feedback loops.

- Even if stiffening lipids increase, cells redistribute them across organelles to maintain **membrane homeostasis**.

- This fine-tuning allows cancer cells to remain mobile, aiding metastasis.

4. Scientific Tools and Future Directions

Biophysicists suggest using:

- **Solid-state NMR** to measure molecular-level changes in lipid dynamics. This could precisely quantify membrane stiffening or fluidity under hypoxia.

Researchers also propose:

- Studying the effect of hypoxia on **other cancers**, since different tumour microenvironments may yield distinct responses.

- Developing **membrane-targeted anticancer therapies** that could disrupt this lipid-based adaptation.

Conclusion

The IIT-Bombay studies reveal how hypoxia, a characteristic feature of pancreatic tumours, rewires membrane lipids and enables cancer cells to migrate more aggressively. Although the mechanisms differ between cell types, the outcome—**enhanced metastatic potential**—remains the same. This research deepens our understanding of cancer biology and opens new pathways for **membrane-targeted therapies** aimed at slowing or preventing metastasis.

As hypoxia-driven lipidome modulation is explored across other cancers, it may become a crucial frontier in personalized oncology.

Ques : How can advances in membrane biophysics and lipidomics contribute to future anti-cancer therapies? Illustrate with recent experimental evidence from Indian research institutions. **(150 words)**

Page 09 : GS 3 : Science and Tech

India's aspiration to become a high-innovation, high-technology economy requires a robust and predictable research ecosystem. The article argues that India cannot rely on public funding alone; instead, it must build steady, long-term private research pipelines that link industries with universities. The experience of the U.S., China, and successful Indian firms shows that the countries which turn science into economic strength consistently match industry spending with campus research capabilities.

India needs research pipelines

India will not meet its growth ambitions on public grants alone. The countries that turned science into industry did one thing well: they matched firm outlays to campus strengths and kept that link steady for years. The policy question is clear. How do we move private research outlays from episodic Corporate Social Responsibility to a predictable pipeline that buys lab time, funds doctoral cohorts, and books pilot lines?

Mamidala Jagadesh Kumar,
Former Chairman, UGC and former Vice-Chancellor, JNU

Global benchmarks

Leading tech firms run innovation budgets at industrial scale. In 2024, Meta's research outlay reached about $44 billion, near a third of revenue. Alphabet, Amazon, Apple, IBM, and Microsoft also reported multibillion-dollar programmes. In the U.S., enterprises booked roughly $692 billion of domestic research against about $14 trillion in net sales in 2022, a ratio near 5%. Policy instruments translate that investment into campus partnerships. The National Science Foundation's Industry-University Cooperative Research Centers pool company fees for pre-competitive university work. The Semiconductor Research Corporation funds multi-university consortia that train talent while tackling industry-relevant problems.

China's Huawei reported an R&D expenditure at 179.7 billion yuan in 2024, equal to 20.8% of revenue. More than half of Huawei's workforce is in R&D roles. Build Your Dreams , a Chinese multinational auto company, invested 54.2 billion yuan in 2024 on R&D against roughly 777 billion yuan of revenue, an intensity of nearly 7%.

These examples demonstrate one trait. Corporate research works with campuses through joint centres, shared lines, long-horizon consortia and open talent pipelines. India should scale this on Indian terms. The goal is self-reliance with open doors to global science while anchoring

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discovery to India's needs. Private research outlays need size, predictability, and structured linkages with higher education institutions (HEIs).

Today, India's GERD sits near 0.65% of GDP, with enterprises funding about two-fifths. Advanced economies show a higher firm share. Yet India has bright spots. Tata Motors reported revenue of about ₹4.38 lakh crore in FY24 and R&D outlay of ₹29,398 crore, an intensity of 6.7%. Sun Pharma invested 6.7% of global revenues on R&D in FY24. Dr. Reddy's spent ₹22.9 billion, about 8.2% of sales. Bharat Electronics dedicated 6.24% of turnover to R&D in FY24, an important signal in a strategic sector. Reliance Industries recorded over ₹4,100 crore of R&D expenditure in FY2024-25.

In terms of partnerships, India already runs strong platforms. IIT Madras Research Park hosts more than 200 companies near faculty labs and student teams, creating a daily flow of ideas and talent. The Ministry of Defence promotes startup and research lab teaming through iDEX. The India Semiconductor Mission pairs industry investments with skill pipelines and academic partnerships, as seen in the Micron ATMP project at Sanand.

Policy actions

These strands form a workable base. The task now is to scale them and set clear expectations for private R&D expenditure and university linkages across sectors. First, we must set three-year R&D-to-sales ratios for autos, pharma, electronics, defence, space and energy that climb year by year, balanced with export goals and cash-flow realities. We must use shared IP frameworks that reward publication and commercialisation together. Second, reward co-funded projects and shared facilities and offer matching grants where industry rupees flow through HEIs for multi-year projects with open data deliverables and

industry-relevant key performance indicators. Create a dedicated line item for university-managed pilot lines and testbeds that industry can book by the hour. Seed multi-university centres around a portfolio of problems rather than isolated projects. Third, modernise tax instruments for research. Weighted deductions can focus on measurable outputs such as patents, standards contributions, clinical milestones or field trials. Link incentives to proof of collaboration with accredited HEIs and to hiring graduate researchers into industry roles. Fourth, teach collaboration. Support campus programmes that train faculty and PhD scholars to work with industry, negotiate IP, and run translational projects. Bring more PhDs into product groups, create dual-track roles with adjunct appointments, and sponsor doctoral cohorts aligned to corporate roadmaps. Fifth, ask listed companies to report R&D investment and the share of spend that flows to Indian HEIs. Disclosure nudges boards to treat research as strategic, not incidental. Publicise results in Indian languages and in practitioner-friendly formats. That builds prestige around research careers and attracts talent.

India's university campuses sit next to some of the world's most dynamic markets, and they carry knowledge traditions that examine technology as part of a broader human inquiry. When corporate research engages that heritage, solutions gain depth and context and match what high-performing corporate R&D needs.

India has the labs, talent, and markets. The task before the industry is clear: set transparent targets, match grants that buy real lab time, and collaborate better. The task before academic institutions is straightforward: shape research for measurable value, welcome industry questions, and show evidence of success. Do that, and research becomes a national supply chain, not wishful thinking.

Key Analysis

1. India's Low GERD and Limited Private Funding

- India's GERD (Gross Expenditure on R&D) is 0.65% of GDP, far below global innovation leaders.

- Enterprises fund only about 40%, whereas advanced economies exhibit much higher private-sector participation.

- This limits the scale, predictability, and quality of India's research output.

2. Global Benchmarks Highlight the Gap

- U.S. companies spent ~$692 billion on research in 2022 (~5% of net sales).

- Tech giants (Meta, Alphabet, Amazon, Microsoft) run industrial-scale R&D budgets.

- China: Huawei spent 179.7 billion yuan (20.8% of revenue) and ~50% of its workforce is in R&D.

- These countries maintain steady industry–university partnerships through consortia, shared labs, and long-term programmes.

3. India's Emerging Bright Spots

Several Indian companies show strong R&D intensity:

- **Tata Motors**: 6.7%

- **Sun Pharma**: 6.7%

- **Dr. Reddy's**: 8.2%

- **Bharat Electronics (BEL)**: 6.24%

- **Reliance Industries**: ₹4,100+ crore in FY25

These firms provide a foundation on which India can build broader and more consistent industry–campus collaboration.

4. Existing Strong Platforms in India

- IIT Madras Research Park: 200+ companies co-located near faculty labs and students.

- iDEX (Defence Ministry): links startups with defence labs.

- India Semiconductor Mission: combines industry investment with academic skill pipelines (e.g., Micron ATMP facility).

These initiatives demonstrate that India already has basic institutional architecture for high-level R&D partnerships.

5. Key Policy Actions Proposed

a) Set Sector-wise R&D-to-Sales Targets

- Autos, pharma, electronics, energy, defence: rising three-year targets.

- Encourage firms to make R&D spending predictable and strategic.

b) Strengthen University–Industry Collaboration

- Matching grants for projects routed through HEIs.

- Shared IP frameworks balancing publication vs. commercialisation.

- Create **multi-university centres** around thematic problems.

- Fund **pilot lines** and testbeds on campuses bookable "by the hour".

c) Modernise Tax Incentives

- Weighted deductions linked to **measurable outputs**: patents, clinical trials, standards contributions.

- Incentives tied to **collaboration with accredited HEIs**.

d) Build Collaboration Skills

- Train faculty and PhD scholars for translational research.

- Introduce dual-track academic–industry roles.

- Corporate-sponsored doctoral cohorts aligned to industry roadmaps.

e) Enhance Transparency

- Mandate listed companies to report:

    o Total R&D spend

    o Share of R&D going to Indian HEIs

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- Publish outcomes in simple formats and Indian languages to build public trust and prestige around research careers.

Conclusion

India's innovation ecosystem has strong laboratories, a large talent pool, and vast markets. What it lacks is a predictable, long-horizon research pipeline that connects industry with academia. By setting sector-specific R&D targets, improving tax incentives, building joint research centres, and cultivating collaboration skills, India can convert research into a national supply chain. If both industry and universities share responsibility—industry funding long-term work and campuses delivering measurable value—India can move rapidly toward self-reliance in advanced technologies while remaining open to global science.

UPSC Mains Practice Question
Ques: India's ambition of becoming a high-technology economy requires predictable, long-term private research pipelines linked to universities. Discuss the challenges in India's current R&D ecosystem and suggest measures to strengthen industry–academia collaboration. **(150 Words)**

Page : 06 : Editorial Analysis

India's disaster response, a slippery slope for federalism

The inter-governmental transfer of resources for disaster response reveals a growing asymmetry between the Union and the States of India, reflected in the widening gap between assessed needs and actual disbursements. This imbalance, seen most recently in the Centre's release of funds to Kerala after the Wayanad landslides, raises a critical question. Is India's fiscal federal structure shifting from a cooperative to a more conditional and centralised model of disaster-risk finance?

The tragedy in Wayanad, in July 2024, which claimed nearly 300 lives and destroyed thousands of homes, brought sharp focus to this issue. Against Kerala's loss of ₹2,200 crore, the Union approved only ₹260 crore, barely 11% (₹1,200 crore is the estimated loss while ₹2,200 crore is sought by the State in the memorandum for recovery). This mismatch, not unique to Kerala, signals an erosion of cooperative federalism. Disasters today are fiscal stress tests for States, and as climate shocks intensify, India's disaster-financing framework is showing visible strain.

There is a drift

India's disaster-response financing framework, established under the Disaster Management Act, 2005, rests on a two-tier structure. The State Disaster Response Fund (SDRF), financed jointly by the Centre and States in a 75:25 ratio, 90:10 for Himalayan and north-eastern States, provides immediate relief for shelter, food, medical care and compensation. The National Disaster Response Fund (NDRF), fully funded by the Union government, supplements this when a calamity is classified as severe. In principle, the design appears balanced, but in practice, it has drifted towards central control.

First, relief norms are outdated and rigid. Compensation ceilings, ₹4 lakh for each life lost and ₹1.2 lakh for a fully damaged house have barely changed in a decade. These amounts meet subsistence needs but not reconstruction costs, leaving States fiscally exposed after every disaster.

Second, ambiguity in classification invites

Aswathy Rachel Varughese

is Assistant Professor, Gulati Institute of Finance and Taxation, Thiruvananthapuram

There is evidence of a more conditional and centralised model of a disaster response financing system

discretion. The Act does not define what constitutes a 'severe' disaster, giving wide latitude to decide eligibility for NDRF aid.

Third, aid releases are procedural, not automatic. Unlike systems where objective indicators trigger support, India's process depends on sequential clearances, State memorandum, central assessment, and high-level approval which cause delays when urgency matters most.

Finally, the Finance Commission's allocation criteria are weak. Using population and total geographical area to gauge exposure ignores actual hazard patterns. Further, the disaster vulnerability is proxied by poverty rather than a robust disaster-risk index, producing allocations that are misaligned with people's real exposure to floods, landslides or cyclones.

The Wayanad episode exposed deep institutional flaws. The Centre cited Kerala's unspent SDRF balance of ₹780 crore and an earlier ₹529 crore interest-free loan under the Capital Investment Scheme to justify the cutting of aid. Yet, these balances often reflect committed works, not idle funds. SDRF instalments arrive late in the fiscal year, while disasters are seasonal, making temporary balances inevitable. Moreover, SDRF rules restrict spending to immediate relief, not reconstruction or livelihood restoration, forcing States to retain reserves for liquidity.

Further, the Centre delayed classifying the Wayanad landslides as a severe disaster, limiting Kerala's access to higher NDRF support. States such as Himachal Pradesh, Uttarakhand, and Assam received larger packages for comparable calamities. Similar mismatches marked Tamil Nadu after Cyclone Gaja (2018) and Karnataka during the 2019 floods. Across cases, procedural rigidity, slow approvals, and widening gaps between losses and aid reveal a system where cooperative federalism has yielded to bureaucratic negotiation.

Learning from global practices

Many countries now use data-driven, transparent disaster financing. The Federal Emergency Management Agency (FEMA) of the United States

applies per capita damage thresholds. Mexico's former FONDEN (fund for natural disasters) released funds automatically when rainfall or wind limits were exceeded. The Philippines triggers quick-response funds through rainfall and fatality indices, while African and Caribbean insurance facilities use satellite data for rapid payouts. Australia links federal aid to a state's relief spending relative to revenue. These systems replace discretion with clear rules, proving that relief can be swift and accountable. India could adopt similar objective triggers such as rainfall intensity, fatalities per million, or loss-to-GSDP ratio to reduce delay, discretion, and restore trust in federal transfers.

Rebuilding the federal spirit

The Sixteenth Finance Commission has an opportunity to reframe this architecture. It can update relief norms to reflect current costs, revise allocation criteria using a comprehensive vulnerability index, and ensure that disaster assistance remains grant-based rather than debt-based. States must have operational control over their disaster funds, with the Union's role confined to post-audit verification instead of prior approval. This reform is not about weakening central oversight but about strengthening federal functionality. A system that enables quick, rules-based responses will serve both tiers of government and, most importantly, citizens far better than one that is mired in procedural red tape.

Disasters expose not only physical vulnerabilities but also institutional ones. When relief turns into negotiation instead of solidarity, fiscal federalism itself comes under strain. India's disaster-financing system must evolve from procedural charity to a rules-based partnership.

The next flood or landslide should not leave States pleading for what the Constitution already guarantees a cooperative, equitable, and timely response. If federalism falters in crisis, it fails when it matters most. The Wayanad tragedy is a warning. Before the next storm arrives, India needs to rebuild the fiscal foundations of its disaster relief.

GS-2: Governance, GS-3 : Environment

UPSC Mains Practice Question : India's disaster-response financing is shifting from cooperative federalism to conditional federalism."Critically examine in the context of the Wayanad landslide incident (2024) and recent Centre–State fund-sharing trends. **(250 words)**

Context :

The article challenges the deeply entrenched idea that democratic systems exist only for human beings. It argues that animals — as sentient, vulnerable, and dependent beings — deserve **formal political representation** within democratic structures. The author critiques anthropocentric political thought and proposes the creation of **independent fiduciary institutions** to safeguard animal interests.

Key Issues and Analysis

1. Anthropocentrism in Modern Democracy

- Democracies historically divide the world into "human" (rational, political) and "animal" (non-rational, non-political).

- Animals are treated as **property**, not as beings with interests.

- This conceptual divide justifies systemic exploitation — industrial farming, entertainment, testing, habitat destruction, etc.

2. Animals as a Heterogeneous Category, Not a Single Mass

The article highlights that:

- "Animals" is not one uniform category.

- Each species has **different vulnerabilities**, creating distinct obligations for humans.

Significance: Laws and policies often treat all animals the same; this ignores species-specific welfare needs.

3. The Problem: Structural Democratic Exclusion

- Animals cannot vote, lobby, litigate or influence policy.

- Governments depend on industries that exploit animals (agriculture, dairy, entertainment), creating **conflict of interest**.

- Existing welfare laws are **reactive**, not preventive.

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- Advisory committees are often dominated by industry interests.

Result: Animal welfare is invisible in policy-making.

4. Proposed Solution: Fiduciary Institutions / Guardians

What are fiduciary institutions?

Bodies whose sole mandate is to represent the interests of a vulnerable group that cannot represent itself.

Why needed?

Just like:

- **children's rights commissions**,
- **environmental agencies**,
- **data protection authorities**, animals too require representation.

What they would do?

- Review laws/policies for their impact on animals.
- Advocate proactively before harm occurs.
- Act independently of political or economic pressures.
- Use scientific evidence (ethology, welfare science) to determine interests.
- Publish transparent assessments and annual audits.

5. Limitations of Current Models

- Example: **Supreme Court Committee on Elephants**
  - o Powerful on paper, weak in practice.
  - o Delayed decisions; lack of urgency; deaths of reported elephants.

This shows the risk of "token institutions" without accountability or independence.

6. Designing Effective Systems of Animal Representation

Institutional features proposed:

- **Operational independence**
  - o Fixed terms, transparent appointments, autonomous budgets.
- **Rule-based procedures**
  - o Mandatory animal-impact assessments for any policy.
- **Expert-driven decision-making**

o   Ethologists, veterinarians, legal experts.

- **Horizontal and vertical accountability**

  o   Annual audits, parliamentary scrutiny, public reporting.

- **Multi-level representation**

  o   National, State, district-level bodies.

- **Non-voting parliamentary delegates**

  o   Experts who provide mandatory input on legislation.

- **Public transparency**

  o   All decisions and reasoning published.

Funding

- Ring-fenced public budgets or reallocation of harmful subsidies.

Gradual implementation

Start with pilot projects (e.g., animal-impact reviews in urban planning).

7. Ethical and Political Philosophy Perspective

- Representation should be based on **sentience**, not human-like cognition.
- Animals impose **moral duties** on humans due to their vulnerability and dependency.
- The article reframes humans as **trustees**, not owners or benevolent caretakers.

Conclusion

The article argues that institutionalising animal representation is not charity but democratic deepening. Democracies already represent humans who cannot speak for themselves; the same logic must extend to animals. Effective fiduciary institutions — independent, expert-led and transparent — can ensure that the interests of animals are considered in law-making and administration. This shift from goodwill to structured responsibility can prevent systemic harm and create a more ethical and inclusive democratic framework.

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