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1. Indigenous air-to-surface RudraM-II missile clears flight trials; Rajnath praises team

Why in the News?

Recently, the **Defence Research and Development Organisation (DRDO)** and the **Indian Air Force (IAF)** successfully flight-tested the indigenous RudraM-II air-to-surface missile from an airborne platform on Tuesday.



Background

- **Predecessor – RudraM-I:** The RudraM series was conceived under the DRDO's Next-Generation **Anti-Radiation Missile (NGARM)** programme. The RudraM-I is an anti-radiation missile designed to destroy enemy radar and communication installations. It was successfully tested in 2020 and is meant for Suppression of Enemy Air Defences (SEAD) missions.
- **RudraM-II Evolution:** RudraM-II is a distinct development, building on the core technological expertise of RudraM-I but designed for a different target set. It has been developed by **Research Centre Imarat (RCI), Hyderabad, the nodal DRDO laboratory, in partnership with DRDL, HEMRL, ARDE,** and the Integrated Test Range (ITR). Major industry partners include Hindustan Aeronautics Limited (HAL) and several private Indian defence firms.

Features

Feature Category	Details
Type & Role	Air-to-surface missile for precision strikes. Unlike the anti-radiation RudraM-I, it is described more broadly, suggesting capabilities

	against hardened ground targets like bunkers, runways, and bridges
Range	Estimated to be in the 300-350 km class, placing it in the stand-off category, allowing launch platforms to stay beyond enemy air defence ranges.
Guidance System	Likely integrates Inertial Navigation System (INS) coupled with GPS for mid-course guidance, with a multi-option terminal seeker (potentially imaging infrared or radio-frequency seeker) for pinpoint accuracy.
Propulsion	Solid rocket motor, designed for supersonic flight to minimise reaction time.
Launch Platform	Primarily being integrated with the IAF's Sukhoi Su-30MKI fighter aircraft, with potential for future integration on platforms like the Mirage-2000 and Tejas.
Warhead	Capable of carrying various conventional warhead configurations

Challenges

- **Propulsion/Air-Launch Dynamics:** The test involved “extreme release conditions,” in which the missile had to withstand extremely high aerodynamic stresses while being launched from a supersonic aircraft before igniting its own propulsion system.
- **Miniaturisation:** Designing and building a long-range propulsion system, seeker, and warhead in a compact frame that would fit onto a fighter's hard point is no easy task.
- **Development of Seekers:** Development of a seeker that is immune to jamming and could strike hardened non-emitting targets with pinpoint accuracy posed a greater challenge than simply developing a passive homing radar seeker.
- **Agency Co-ordination:** The success of the project depended on perfect co-ordination between RCI and various DRDO laboratories, including DRDL, HEMRL, and ARDE, along with the IAF, testing agencies, and numerous PSUs and private industries.

Way Forward

- **Further Flight Trials:** The IAF would have to undertake further trials in the form of captive and live launches from multiple aircraft across ranges to fully certify its performance envelope in various flight environments.
- **Multiple Platform Integration:** Broadening the number of compatible launching platforms to include other aircraft apart from the Su-30MKI, such as the improved Mirage-2000 and Tejas Mk1A.
- **Increased Production:** Increasing production through development cum production partners and domestic industries in India to meet the requirements of the IAF.
- **Enhancement of Capability:** Possible future variants may include anti-radiation homing capabilities along with the RudraM-I and II seekers or even extended-range variants.

Conclusion

The successful test of the RudraM-II missile is an essential step forward in achieving self-sufficiency in India's strike missiles, as it cuts down dependency on foreign missile systems such as the Russian Kh-31 or the French Armement Air-Sol Modulaire (AASM). This will enhance the ability of the Indian Air Force to conduct stand-off strikes with precision and safety, thus ensuring a conventional deterrent. This milestone reflects how India's missile programme is becoming increasingly mature.

2. India losing ability to build its own instruments: climate science report

Why in the News?

The Mega Science Vision-2035 (MSV) report on Climate Research, prepared by IISc Bengaluru and submitted to the Principal Scientific Adviser (PSA), has raised a red flag: India is losing its ability to build scientific instruments and relies on imported, uncalibrated equipment, leading to "incorrect data" and a credibility crisis in Indian climate science.



Background

- India faces serious climate issues: heatwaves, erratic monsoons, melting glaciers.
- To track these, accurate instruments are essential.
- Traditionally, India made its own instruments, but that capability has declined.

- The government promotes "**Atmanirbhar Bharat**" (self-reliance), but rules like mandatory purchase from the lowest-bidding vendor on the Government e-Marketplace (GeM) have backfired. Scientists cannot buy high-quality custom equipment easily. Global tenders face long delays.
- In June 2025, some rules were relaxed because of complaints about poor quality.

Feature

- **Instrument problem:** India has "almost lost" its ability to build its own climate instruments. Imported instruments run uncalibrated for years → incorrect data → questions on the credibility of Indian science.
- **Renewable energy concern:** The report warns about "uncontrolled" growth of solar and wind farms. Their long-term climate impact is "poorly understood."
- **Other recommendations:**
 - Build an indigenous Earth System Model (not adapted from the US/Europe).
 - Study the social cost of carbon and implement the "polluter pays" principle.
 - Protect the poor from any carbon tax burden.
 - Eight "mega projects" (observatories, satellites, sensors, etc.) by 2035.

Challenge

- GeM rules meant to boost local manufacturing actually stop scientists from getting good-quality, custom-made equipment, striking a balance between self-reliance and quality.
- **Credibility issue with data:** Incorrect data from uncalibrated instruments hurts India's image in international journals and climate talks.
- **Renewable energy paradox:** India has committed itself to 500 GW of non-fossil capacity by 2030 (halfway there, in 2025). But in the long term, the environmental impact of large solar/wind farms is not really known.
- **No indigenous models:** Indian climate models are mostly adapted versions of US/Europe models, rather than developed from first principles.

Way Forward

- **Change procurement policies:** Provide leeway to scientific bodies to procure expensive but good-quality instruments without red tape.
- **Build capacity for instrument manufacture:** Develop specialised facilities and skills within India to produce precision climate instruments, not merely cheap ones.
- **Research long-term impacts of renewable energy:** Study the impacts of large-scale solar/wind power plants on local climate.
- **Develop an Indian Earth System Model:** Create India's own earth system model from the ground up.
- **Polluter pays:** Ensure the polluter pays, but without burdening the poor with high costs.

Conclusion

India can never combat climate change with bad data. The Mega Science Vision-2035 report should sound the alarm bell for all of us. It requires being self-reliant, which in turn involves producing reliable and accurate instruments rather than inexpensive ones. If India wants its climate scientists to be taken seriously worldwide, it must revise its procurement policies and revive its ability to produce instruments.

3. AIIMS Delhi study shows how air pollutants breach placental barriers and affect fetuses

Why in the News?

A recent study funded by **ICMR** and done by researchers at **All India Institute of Medical Sciences** was published in **EMBO Molecular Medicine**. This study has mapped how urban air pollution, fine **particulate matter (PM2.5)**, crosses the placental barrier and affects foetal development. The study finds a link between the air pollution that mothers are exposed to and impaired growth of the foetus. It does so by identifying that a **crucial protein, IGFBP3**, which regulates growth is suppressed. The study is about the effects of air pollution on development and the role of the IGFBP3 protein. The researchers looked at how air pollution impacts the growth of the foetus.

Background

Air pollution is one of the most significant environmental health risks globally. India is home to several of the world's most polluted cities, with urban centres such as Delhi frequently recording PM2.5 levels far above recommended standards.

What is PM2.5?

PM2.5 refers to particulate matter with a diameter of less than 2.5 micrometres. Due to their extremely small size, these particles can:

- Penetrate deep into the lungs.
- Enter the bloodstream.
- Reach various organs, including the placenta during pregnancy.

Previous research had already established associations between maternal exposure to air pollution and adverse pregnancy outcomes such as:

- Low birth weight (LBW)
- Pre-term birth
- Preeclampsia
- Stillbirth
- Developmental disorders

However, the precise biological mechanism through which pollutants crossed the placental barrier and affected foetal development remained insufficiently understood.

Features

First Comprehensive Molecular Mapping

The AIIMS study traced the entire biological pathway linking PM2.5 exposure to impaired foetal growth, moving beyond earlier fragmented evidence.

Identification of IGFBP3 Suppression

The study identified that urban particulate matter activates inflammatory pathways that suppress the expression of:

Insulin-like Growth Factor Binding Protein-3 (IGFBP3)

This protein plays a crucial role in:

- Placental homeostasis

- Embryonic growth
- Nutrient exchange
- Cellular development

Reduced IGFBP3 levels disrupt normal placental functioning and foetal growth.

Placental Damage Mechanism

The study found that PM2.5 exposure:

- Crosses the placental barrier.
- Triggers oxidative stress.
- Activates inflammatory responses.
- Alters epigenetic regulation of genes.
- Impairs placental development and vascularisation.

As a result:

- Nutrient transfer to the foetus declines.
- Placental efficiency decreases.
- Foetal growth becomes restricted.

Human Population Findings

Researchers analysed delivery records of:

- 994 women
- From highly polluted Delhi and relatively less polluted Deoghar (Jharkhand)

Findings

- PM2.5 exposure emerged as a significant risk factor for low birth weight.
- Incidence of preeclampsia increased with rising pollution levels.



- Pregnant women in highly polluted environments faced greater pregnancy complications.

Animal Model Findings

- Reduced placental size
- Impaired invasion of the uterine wall
- Defective nutrient-exchange layer formation
- Poor blood vessel development

Foetal Effects

- Litter sizes reduced by up to 25%.
- Birth weights reduced by nearly 34%.

Neurological Effects

Offspring exhibited:

- Impaired motor coordination
- Increased anxiety behaviour
- Heightened stress responses

These findings indicate that pollution-induced damage begins during foetal development and can persist after birth.

Significance of the Study

Scientific Significance

- Establishes a clear causal biological pathway.
- Enhances understanding of environmental epigenetics.
- Opens avenues for targeted interventions during pregnancy.

Public Health Significance

- Highlights pregnant women as a highly vulnerable group.
- Strengthens evidence linking pollution with developmental disorders.
- Supports integration of environmental exposure assessments into maternal healthcare.

Policy Significance

- Reinforces the urgency of reducing urban air pollution.
- Provides evidence for strengthening air quality standards.
- Supports pollution-sensitive maternal and child health programmes.

Way Forward

- **Monitor pollution during pregnancy:** The researchers believe that checking air quality should become a part of pregnancy care, just like checking blood pressure. This is something that we need to do when we talk about pregnancy and pollution.
- **Study the long-term effects:** We need to follow up on children who were exposed to pollution in the womb to understand the lifelong impact of pollution. We need to think about pollution and its effects on children.
- **Push for air:** The real solution is a large-scale effort to reduce pollution at its source. We need to push for air and think about pollution.

Conclusion

AIIMS study has drawn a map of how air pollution affects an unborn baby: it crosses the placenta, creates stress and inflammation and then turns off a vital protein that helps the baby grow. Air pollution is a problem that we need to think about. The result is underweight babies with a higher risk of brain and developmental issues. The findings are a warning that protecting pregnant women from air pollution is critical and should be a public health priority. We need to think about air pollution and its effects on our lives.

4. The 'harvest' China wants is one India cannot afford

Why in the News?

India and China are discussing an "**Early Harvest**" solution to their long-standing border dispute. China wants to settle the Sikkim border sector first, while leaving other disputed areas unresolved. Many experts believe this could benefit **China more than India** and weaken India's bargaining position.



Background

- India and China share a disputed border of about **3,488 km**.
- The dispute covers four sectors:
 - Western Sector (Ladakh)
 - Middle Sector (Himachal Pradesh and Uttarakhand)
 - Sikkim Sector
 - Eastern Sector (Arunachal Pradesh)
- In 2005, both countries agreed that the boundary issue should be resolved through a comprehensive package settlement, not sector by sector.

Features

What is the "Early Harvest" Proposal?

- China wants to settle the Sikkim boundary first.
- It argues that this sector is easier to resolve than others.
- India fears that once Sikkim is settled, China may become less willing to compromise elsewhere.

Importance of Sikkim and Doklam

- The Sikkim sector is close to the Doklam Plateau, where India and China faced a military standoff in 2017.
- It is also near the **Siliguri Corridor ("Chicken's Neck")**, which connects mainland India to the Northeast.

China's Strategy

- China prefers settling disputes in parts where it has an advantage.
- It has also strengthened infrastructure and military presence along the border.

Challenges

Loss of Negotiating Power

- Settling Sikkim separately could reduce India's leverage in Ladakh and Arunachal Pradesh.

Security Risks

- Any change near Doklam could affect the security of the Siliguri Corridor, India's strategic lifeline to the Northeast.

Trust Deficit

- Relations remain strained after the 2020 Galwan and Eastern Ladakh incidents.
- India remains cautious about China's intentions.

Pressure on Bhutan

- A Sikkim settlement may increase Chinese pressure on Bhutan regarding the Doklam region.

Way Forward

- Follow the 2005 Agreement, which calls for a comprehensive settlement.
- Ensure peace and stability along the Line of Actual Control (LAC).
- Continue close coordination with Bhutan.
- Strengthen border infrastructure and military preparedness.
- Pursue sustained political dialogue for a final settlement.

Conclusion

India should be cautious about accepting a separate settlement in Sikkim. While an "Early Harvest" may appear to be progress, it could weaken India's strategic position in the larger border dispute. A comprehensive settlement covering all sectors remains the safest and most balanced approach.

5. U.S.-Iran negotiations, still a road to nowhere

Why in the News?

The United States and Iran are engaged in negotiations on a memorandum that could lead to an indefinite ceasefire after recent military confrontations. However, major disagreements over Iran's nuclear programme, regional security, and mutual distrust continue to make a lasting peace agreement difficult.

Background

- U.S.-Iran relations have remained hostile since the 1979 Iranian Revolution.
- **Disputes revolve around:**
 - Iran's nuclear programme.
 - Ballistic missile development.
 - Regional influence through proxy groups.
 - U.S. sanctions on Iran.
- The 2015 nuclear deal (JCPOA) temporarily reduced tensions but later collapsed, leading to renewed confrontation.

Features

Renewed Negotiations

- Both countries are exploring a memorandum that could create a ceasefire and provide time for further negotiations.
- The objective is to prevent another costly military confrontation.



High Cost of Conflict

- The U.S. and Israel inflicted damage on Iran's military infrastructure.

- Iran still retains the ability to disrupt regional stability through proxies and strategic waterways such as the Strait of Hormuz.
- Both sides recognise that prolonged conflict would have serious economic and political consequences.

Focus on Nuclear and Missile Issues

- The U.S. wants stronger restrictions on Iran's nuclear and missile programmes.
- Iran seeks security guarantees and relief from pressure and sanctions.

Challenges

Deep Mutual Distrust

- Iran believes the U.S. ultimately seeks regime change.
- The U.S. suspects Iran uses negotiations to buy time and preserve its nuclear capabilities.

Domestic Opposition

- Hardliners in both countries oppose major compromises.
- In Iran, the Islamic Revolutionary Guard Corps (IRGC) remains influential.
- In the U.S., critics fear another weak nuclear agreement.

Israel Factor

- Israel views Iran's nuclear and missile capabilities as a major security threat.
- Israeli military or covert actions could disrupt diplomatic efforts.

Nuclear Weapons Question

- Many Iranian hardliners believe only nuclear weapons can guarantee national security.
- Iran is therefore unlikely to permanently abandon the nuclear weapons option.

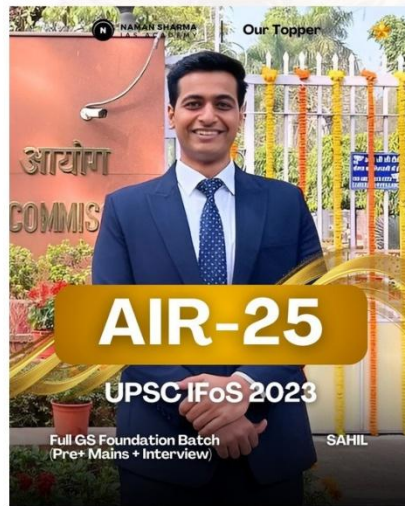
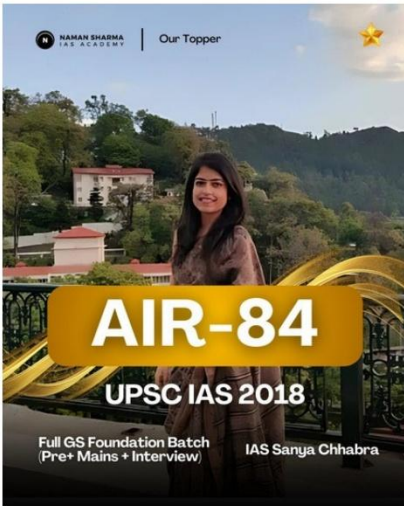
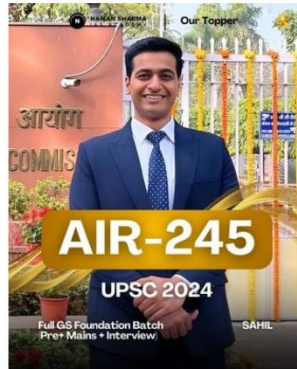
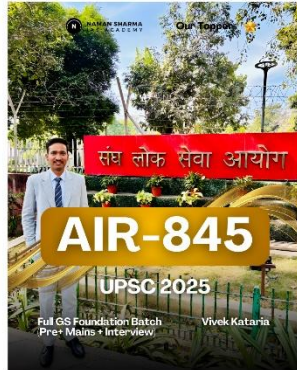
Way Forward

- Build confidence through gradual diplomatic engagement.
- Negotiate stronger verification mechanisms for Iran's nuclear programme.
- Reduce regional tensions through dialogue involving Gulf countries.
- Encourage restraint by all regional actors, including Israel.
- Work toward a broader regional security framework in West Asia.

Conclusion

A temporary ceasefire or memorandum between the U.S. and Iran may be achievable because both sides want to avoid the costs of another conflict. However, deep mistrust, nuclear disagreements, domestic political opposition, and regional rivalries mean that a comprehensive and lasting peace remains difficult to achieve.

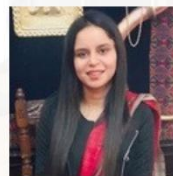
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