MISSION X

INNOVATION IN LEARNING

MISSION X PRESENTS

X TECH

WEEKLY SCIENCE & TECHNOLOGY COMPILATION

25 July – 1 August 2026

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SECTION

Space Technology

01 PRAXIS — NASA's Ring-Sampling Mission Concept

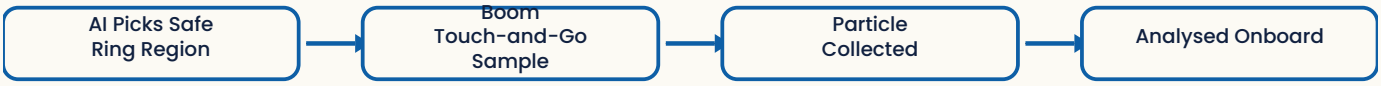
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GS PAPER III · SPACE TECHNOLOGY · PLANETARY SCIENCE

PRAXIS — NASA's Ring-Sampling Mission Concept



NEWS IN BRIEF

- NASA announced the PRAXIS mission concept on 26 July 2026 — Planetary Rings Autonomous EXploration with In-situ Sampling — aimed at the first-ever direct sampling of particles from a planetary ring system, primarily Saturn.
- Developed at NASA's Jet Propulsion Laboratory under Dr. B. Marco Quadrelli, PRAXIS received NASA Innovative Advanced Concepts (NIAC) 2026 Phase I funding in March 2026, an early feasibility-study stage, not a confirmed flight mission.
- It uses an AI-powered, bio-inspired robotic system with a long deployable boom for touch-and-go sampling of millimetre-to-centimetre ring particles, avoiding direct collision with the ring structure.
- Because Saturn is nearly 1.4 billion km away, round-trip communication takes hours, so PRAXIS relies on onboard AI to autonomously pick safe sampling targets and avoid hazards in real time.

CONCEPT SIMPLIFIED

Planetary rings are disc-shaped bands of ice, dust and rock orbiting within or near a planet's Roche limit — the distance at which gravity would tear apart a larger body, keeping ring material as small fragments. Unlike Cassini, which studied Saturn's rings remotely with cameras and instruments, PRAXIS is designed to physically touch and retrieve particles, giving direct compositional data remote sensing cannot capture.

NIAC Phase I	mm to cm	Cassini
Funding Stage	Particle Size	Predecessor

STATIC CONNECT

Static connect — Solar System & Planetary Science: revise the Roche limit and ring composition around Saturn, Jupiter, Uranus and Neptune, and compare with the earlier Cassini-Huygens mission.

UNIQUE FACT

Because a round-trip radio signal between Earth and Saturn can take over two hours, PRAXIS would need to make split-second sampling decisions entirely on its own, with no real-time human guidance.

⚠ **EXAM TRAP —** PRAXIS is currently only an early-stage NIAC Phase I concept study, not a confirmed, funded flight mission — don't mistake feasibility-study funding for an approved launch.

RELEVANCE

- Would help answer questions the Cassini mission (2004-2017) could observe but not resolve — how rings originate, evolve and are composed at the particle level.
- Its AI-driven autonomous sampling is a template for future deep-space missions facing similar multi-hour communication delays.
- Shows how space agencies de-risk ambitious concepts through incremental NIAC funding phases before committing full mission budgets.

📌 PRELIMS MEMORY BANK

- Announced: 26 July 2026, by NASA
- Full form: Planetary Rings Autonomous EXploration with In-situ Sampling
- Lead: Dr. B. Marco Quadrelli, NASA JPL
- Funding stage: NIAC 2026 Phase I (feasibility study, not confirmed mission)
- Target: Saturn's rings; method: AI-powered touch-and-go sampling

PRACTICE MCQ · UPSC PRELIMS STYLE

PRAXIS — NASA's Ring-Sampling Mission Concept

With reference to NASA's PRAXIS mission concept, consider the following statements:

1. It aims to achieve the first direct, in-situ sampling of particles from a planetary ring system.
2. It has already been confirmed as a fully funded flight mission set for launch.
3. It relies on AI-driven autonomy due to significant communication delays with Earth.

Which of the statements given above is/are correct?

(a) 1 and 3 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 1 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

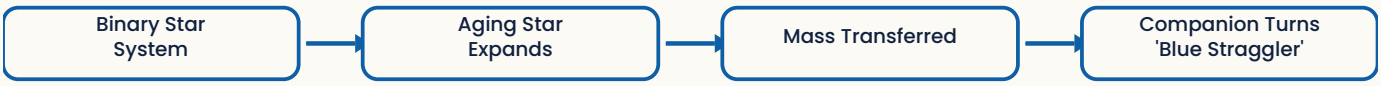
NIAC Phase I is explicitly early-stage feasibility funding for 'advanced concepts', not mission-confirmation funding — a statement claiming full flight-mission confirmation overstates what this funding stage represents.

② THROUGH FACTUAL KNOWLEDGE

PRAXIS aims for the first-ever in-situ sampling of planetary ring particles; it holds only NIAC Phase I feasibility funding; and its AI-driven autonomy is designed specifically for Saturn's multi-hour communication delay.

GS PAPER III · SPACE TECHNOLOGY · ASTROPHYSICS

Blue Straggler Star Caught Forming Live



NEWS IN BRIEF

- India's DST announced on 27 July 2026 that astronomers from the Indian Institute of Astrophysics (IIA), with international collaborators, directly observed a Blue Straggler Star forming in binary system TIC 327546480, in the ancient open cluster Collinder 261.
- Confirmed using TESS, the Very Large Telescope and X-ray data, the star is actively 'stealing' mass from its binary companion — a process ongoing for roughly 5.46 billion years per evolutionary simulations.
- Blue Straggler Stars have puzzled astronomers since Allan Sandage first identified them in 1953 in globular cluster M3 — appearing younger, hotter and more massive than they should, given cluster stars form around the same time.
- A January 2026 Hubble study of 3,000+ Blue Stragglers across 48 globular clusters found their numbers correlate with a cluster's binary-star fraction rather than collision rate, favouring mass transfer as the dominant formation mechanism — this discovery gives rare live confirmation.

CONCEPT SIMPLIFIED

In a binary system, as one star ages and expands, it can spill outer material onto its companion through gravitational interaction. This mass transfer makes the receiving star hotter, more massive and bluer — appearing artificially 'young' compared to cluster stars that formed at the same time but received no extra mass, creating the Blue Straggler puzzle.

~5.46 bn yrs	9,500 ly	1953, M3
Process Duration	Distance	First Discovered

STATIC CONNECT

Static connect — Stellar Evolution: revise binary star systems and stellar life-cycle basics, linked to Hubble's finding that binary fraction (not collision rate) best explains Blue Straggler populations.

UNIQUE FACT

The mass-transfer process observed in TIC 327546480 has been continuously ongoing for about 5.46 billion years — roughly as long as Earth's own solar system has existed.

⚠ **EXAM TRAP —** Don't assume Blue Straggler Stars are genuinely young — they only appear young/hot/blue from mass gained from a companion; they are actually the same age as the rest of their host cluster.

RELEVANCE

- Provides rare direct evidence settling a decades-old debate between mass transfer and stellar-collision theories for these anomalous stars.
- Improves broader models of binary star evolution and stellar life cycles underpinning astronomy generally.
- Demonstrates India's growing role in frontier observational astrophysics via IIA, working with international telescope data.

📌 PRELIMS MEMORY BANK

- Discovery announced: 27 July 2026, by India's DST
- System: TIC 327546480, in open cluster Collinder 261
- Institution: Indian Institute of Astrophysics + international collaborators
- Mechanism confirmed: mass transfer in a binary system (not collision)
- First BSS discovery: Allan Sandage, 1953, globular cluster M3

PRACTICE MCQ · UPSC PRELIMS STYLE

Blue Straggler Star Caught Forming Live

With reference to Blue Straggler Stars, recently in the news, consider the following statements:

1. They are genuinely younger than the other stars in their host cluster.
2. Recent evidence favours mass transfer in binary systems over stellar collisions as their dominant formation mechanism.
3. They were directly observed forming in system TIC 327546480 by Indian astronomers.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Every explanation of the Blue Straggler puzzle stresses these stars only APPEAR younger due to mass gained, while all cluster members actually formed together — a statement claiming genuine youth misses this core paradox.

② THROUGH FACTUAL KNOWLEDGE

Blue Stragglers are the same age as their cluster but appear younger due to mass transfer; a January 2026 Hubble study favoured mass transfer over collision; and Indian astronomers directly observed this in TIC 327546480, announced 27 July 2026.

GS PAPER III · SPACE TECHNOLOGY · ASTRONOMY

Andromeda Galaxy — Star Formation Winding Down

~1 M☉/yr	~0.2 M☉/yr	2.5M ly
Past Rate	Current Rate	Distance

NEWS IN BRIEF

- New Hubble observations reported 27 July 2026 show star formation in the Andromeda galaxy (M31) has declined steadily for roughly 500 million years, dropping from ~1 solar mass of new stars/year to ~0.2 today, with an accelerated decline over just the last 40 million years.
- Andromeda, about 2.5 million light-years away, is the Milky Way's closest large neighbouring spiral galaxy, offering a detailed nearby laboratory for galaxy ageing and evolution.
- Separately, in June 2026 astronomers confirmed a new ultra-faint dwarf satellite galaxy near Andromeda, named Andromeda XXXVI, estimated at ~12.5 billion years old with only about 46 resolved stars — one of the faintest satellites ever found around M31.
- Andromeda XXXVI was first spotted by amateur astronomer Giuseppe Donatiello in public survey images, later confirmed with the 10.4-metre Gran Telescopio Canarias; researchers estimate Andromeda may host close to 100 dwarf satellites, with only about half identified so far.

CONCEPT SIMPLIFIED

A galaxy's star formation rate measures new stellar mass produced per year from its gas and dust reserves; as a galaxy ages and consumes or loses that material, star formation slows — a process called 'quenching'. Studying Andromeda's decline up close previews how the Milky Way, a similar spiral galaxy, may also evolve.

Gas & Dust Deplete → Star Formation Declines → Galaxy 'Quenches' → Preview of Milky Way

STATIC CONNECT

Static connect — Galactic Astronomy: revise galaxy types (spiral, elliptical, dwarf) and 'quenching' alongside dark matter's role in galaxy formation.

UNIQUE FACT

Andromeda XXXVI is so faint that only about 46 individual stars have been resolved in it, yet its population still allowed an age estimate of roughly 12.5 billion years — a near-fossil record of the early universe.

⚠ **EXAM TRAP —** Don't confuse Andromeda (M31, the large spiral galaxy) with Andromeda XXXVI (a tiny, separate ultra-faint dwarf satellite galaxy orbiting it) — entirely different objects at very different scales.

RELEVANCE

- Because Andromeda is close enough to resolve individual stars, it is a benchmark test case for galaxy-evolution models applied to more distant galaxies.
- Ultra-faint dwarf satellites like Andromeda XXXVI, dark-matter dominated and chemically unevolved, act as fossil windows into the early universe.
- Shows the ongoing role of citizen/amateur astronomers using public survey data alongside professional observatories.

📌 PRELIMS MEMORY BANK

- Star formation decline reported: 27 July 2026 (Hubble)
- Current rate: ~0.2 solar masses/year (down from ~1)
- Distance to Andromeda: ~2.5 million light-years
- New satellite galaxy: Andromeda XXXVI, confirmed June 2026
- Andromeda XXXVI age: ~12.5 billion years; only ~46 stars resolved

PRACTICE MCQ · UPSC PRELIMS STYLE

Andromeda Galaxy — Star Formation Winding Down

Consider the following statements regarding recent findings about the Andromeda galaxy:

1. Star formation in Andromeda has been accelerating over the last 500 million years.
2. Andromeda XXXVI is a newly confirmed ultra-faint dwarf satellite galaxy near Andromeda.
3. Andromeda is located within our own Milky Way galaxy.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Hubble's newsworthy finding is specifically a DECLINE in star formation — a statement claiming acceleration reverses the reported trend. Andromeda is described as the Milky Way's 'closest neighbouring' galaxy, so placing it within the Milky Way conflates two separate galaxies.

② THROUGH FACTUAL KNOWLEDGE

Hubble data shows Andromeda's star formation rate declining, not accelerating; Andromeda XXXVI was newly confirmed as an ultra-faint dwarf satellite in 2026; and Andromeda is a separate, neighbouring galaxy, not part of the Milky Way.

GS PAPER III · SPACE TECHNOLOGY · ASTRONOMY INFRASTRUCTURE

Chandra X-ray Observatory — Funding Battle Resolved

FY2026 Budget Proposes Cut → Save Chandra Campaign → Congress Passes Bill (Jan 2026) → Funding Restored

NEWS IN BRIEF

- NASA's Chandra X-ray Observatory, launched 1999 and one of NASA's four 'Great Observatories', faced proposed termination under the White House's FY2026 budget request, seeking nearly 50% NASA Science cuts.
- In January 2026 Congress passed a bipartisan 'minibus' appropriations bill rejecting the proposed terminations, restoring funding for Chandra and over a dozen other threatened NASA science missions at roughly flat 2025-level funding.
- Despite this, in February 2026 the White House's OMB briefly instructed NASA to pause financial commitments on Chandra and other missions pending further budget guidance, alarming astronomers before continuation was confirmed.
- A sustained 'Save Chandra' advocacy campaign by astronomers and Congress members, warning of lost workforce and ceded US leadership in X-ray astrophysics, is credited with helping secure the funding reversal.

CONCEPT SIMPLIFIED

An X-ray space telescope like Chandra observes extremely high-energy phenomena — black holes, supernova remnants, neutron stars, hot gas in galaxy clusters — that emit X-rays rather than visible light. Earth's atmosphere blocks X-rays, so this astronomy can only be done from space, and Chandra's high-resolution X-ray imaging remains unmatched by other current missions.

1999	~$63-68M	4
Launch Year	Annual Cost	Great Observatories

STATIC CONNECT

Static connect — Great Observatories Programme: link NASA's four Great Observatories (Hubble, Compton Gamma Ray Observatory, Spitzer, Chandra) and their wavelength specialisations, alongside India's AstroSat for comparison.

UNIQUE FACT

Despite being threatened to save its roughly $68 million annual operating cost, Chandra was ultimately saved in the same bill that gave NASA its highest overall budget in almost three decades once human-spaceflight funding was included.

⚠ **EXAM TRAP —** Don't assume Chandra's funding crisis is fully resolved forever — even after the January 2026 restoration, a brief OMB pause in February 2026 showed its budget can still be challenged in future cycles.

RELEVANCE

- Illustrates how scientific infrastructure funding is subject to political and budgetary cycles, not purely scientific merit.
- Chandra's data continues to synergise with Hubble and James Webb, contributing to discoveries like identifying the most distant known supermassive black hole.
- Shows the real cost (tens of millions annually) of maintaining Great Observatory-class infrastructure versus the value of irreplaceable long-term datasets.

📌 PRELIMS MEMORY BANK

- Launched: 1999; one of NASA's four Great Observatories
- Threatened by: FY2026 budget request (~50% NASA Science cut proposed)
- Saved by: January 2026 bipartisan Congressional appropriations bill
- Annual operating cost: ~$63-68 million
- Advocacy: 'Save Chandra' campaign by astronomers and Congress members

PRACTICE MCQ · UPSC PRELIMS STYLE

Chandra X-ray Observatory — Funding Battle Resolved

With reference to NASA's Chandra X-ray Observatory, consider the following statements:

1. It is one of NASA's four 'Great Observatories', alongside Hubble, Spitzer and the Compton Gamma Ray Observatory.
2. Its proposed termination under the FY2026 budget request was ultimately upheld by Congress.
3. It observes phenomena in the X-ray wavelength, which cannot be studied by ground-based telescopes.

Which of the statements given above is/are correct?

(a) 1 and 3 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 1 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

A bipartisan Congressional bill described as 'rejecting the mission terminations' is the opposite of Congress UPHOLDING the proposed cuts — that statement reverses the actual legislative outcome.

② THROUGH FACTUAL KNOWLEDGE

Chandra is one of NASA's four Great Observatories; Congress's January 2026 bill explicitly rejected the proposed terminations; and X-ray astronomy must be conducted from space since Earth's atmosphere blocks X-rays.



SECTION

Defence Technology

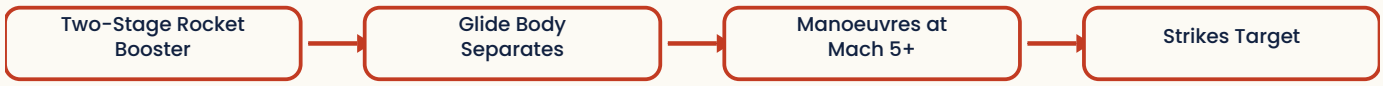
05 Dark Eagle — US Hypersonic Weapon Nears Deployment

06 Bhargavastra — Counter-Swarm Drone System Demonstrated

07 Kh-101 Missile Crosses into Polish Airspace

GS PAPER III · DEFENCE TECHNOLOGY · HYPERSONIC WEAPONS

Dark Eagle — US Hypersonic Weapon Nears Deployment



NEWS IN BRIEF

- The US Army's Long-Range Hypersonic Weapon (LRHW), officially named 'Dark Eagle' in April 2025, has moved toward first operational fielding through 2026, with a battery at Joint Base Lewis-McChord designated to receive its first operational missiles.
- Dark Eagle combines a two-stage rocket booster with a Common Hypersonic Glide Body that separates mid-flight and travels above Mach 5 while manoeuvring unpredictably, giving it a reported range over 3,500 km.
- The programme has cost over $12 billion since 2018 and faced repeated delays; a March 2026 Pentagon assessment found insufficient data to confirm the system is fully 'operationally effective', even as fielding proceeds.
- In May 2026, Leidos secured a $2.7 billion Army contract to move the glide body and its thermal protection shield from testing into repeatable production, aiming to transition Dark Eagle into a deployable combat weapon.

CONCEPT SIMPLIFIED

A 'boost-glide' hypersonic weapon like Dark Eagle first uses a rocket booster to accelerate to high altitude and hypersonic speed, then releases a glide body that no longer needs propulsion — gliding through the upper atmosphere at extreme speed while manoeuvring laterally, unlike a ballistic missile's predictable arc, making it far harder for missile defences to predict and stop.

3,500+ km	Mach 5+	$12+ billion
Range	Speed	Programme Cost

STATIC CONNECT

Static connect — Hypersonic Weapons Race: link to DRDO's Hypersonic Technology Demonstrator Vehicle and compare boost-glide systems with hypersonic cruise missiles as a distinct weapon category.

UNIQUE FACT

Despite being fielded to operational units in 2026, a Pentagon assessment as recently as March 2026 stated there was still insufficient data to confirm Dark Eagle is fully 'operationally effective' — deployment ahead of complete validation.

⚠ **EXAM TRAP —** Don't confuse a boost-glide hypersonic weapon (Dark Eagle — manoeuvres unpredictably after separation) with a traditional ballistic missile (fixed, predictable arc) — manoeuvrability is what makes glide weapons hard to intercept.

RELEVANCE

- Gives the US Army a long-range, conventional precision strike capability against heavily defended, time-sensitive targets.
- Reflects the global hypersonic arms race alongside China's DF-17 and Russia's Avangard, shaping strategy in contested regions like the Indo-Pacific.
- Its glide body technology transfers to the Navy's Conventional Prompt Strike programme, showing shared tech across branches.

📌 PRELIMS MEMORY BANK

- Official name given: April 2025 ('Dark Eagle')
- Speed: exceeds Mach 5; Range: 3,500+ km
- Programme cost: $12+ billion since 2018
- Fielding unit: Joint Base Lewis-McChord battery (2026)
- Recent contract: $2.7 billion to Leidos (May 2026, production scale-up)

PRACTICE MCQ · UPSC PRELIMS STYLE

Dark Eagle — US Hypersonic Weapon Nears Deployment

Consider the following statements regarding the US Army's Dark Eagle hypersonic weapon:

1. It follows a fixed, predictable ballistic trajectory similar to a conventional ballistic missile.
2. It uses a Common Hypersonic Glide Body that separates from its booster mid-flight.
3. As of March 2026, the Pentagon had confirmed with complete data that the system was fully operationally effective.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The strategic value of a hypersonic GLIDE weapon lies in unpredictable manoeuvring — describing it as following a fixed ballistic arc erases this defining distinction. A Pentagon report flagging insufficient data contradicts a claim of full confirmation.

② THROUGH FACTUAL KNOWLEDGE

Dark Eagle uses a Common Hypersonic Glide Body manoeuvring unpredictably after separation; and the Pentagon's March 2026 assessment stated there was insufficient data to confirm full operational effectiveness.

GS PAPER III · DEFENCE TECHNOLOGY · COUNTER-DRONE SYSTEMS

Bhargavastra — Counter-Swarm Drone System Demonstrated

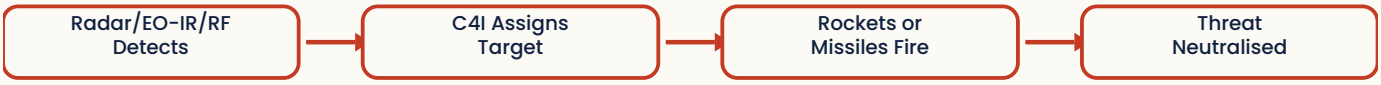
10 km	6 km	2.5 km
Large UAV Detection	Small Drone Detection	Missile Range

NEWS IN BRIEF

- Solar Defence and Aerospace Ltd (SDAL) demonstrated its indigenous, vehicle-mounted Bhargavastra Counter-Swarm Drone System to a senior Indian Army team at Nagpur on 24 July 2026, under the Army's Make-II programme.
- Bhargavastra uses a multi-layer hard-kill approach: unguided micro-rockets with a ~20-metre lethal blast radius for dense drone swarms, plus precision-guided micro-missiles effective up to 2.5 km for individual high-value targets.
- It integrates radar, electro-optical/infrared sensors and passive RF detectors through a C4I network — detecting larger UAVs up to 10 km away and smaller drones up to 6 km — designed for deserts, plains and altitudes up to 5,000 metres.
- Final trials are projected to conclude within 2-3 months of the July 2026 demonstration; if successful, Bhargavastra would be among the world's first fully integrated, vehicle-mounted, multi-layer counter-swarm drone systems.

CONCEPT SIMPLIFIED

A 'hard-kill' counter-drone system physically destroys an incoming drone using kinetic rockets or missiles, unlike a 'soft-kill' system that disables it electronically via jamming or spoofing. Bhargavastra's layered design uses cheap unguided micro-rockets for large, cheap drone swarms, reserving precision-guided micro-missiles for higher-value threats — avoiding the unsustainable cost of using expensive standard missiles against cheap drones.



STATIC CONNECT

Static connect — Indigenous Defence & Drone Warfare: link to India's counter-drone ecosystem (Akashteer, Integrated Air Command and Control System) and the Make-II procurement category for private-sector defence development.

UNIQUE FACT

Bhargavastra's open-source architecture allows an additional 'soft-kill' layer (jamming and spoofing) to be added later as a modular upgrade, extending its protective shield beyond its initial hard-kill rockets and missiles.

⚠ **EXAM TRAP —** Don't confuse Bhargavastra (a hard-kill, vehicle-mounted counter-swarm drone system by SDAL) with DRDO's Project Kusha (a long-range surface-to-air missile for aircraft/cruise missiles) — Bhargavastra targets cheap drone threats, not high-value aerial targets.

RELEVANCE

- Directly addresses the fast-growing threat of cheap, mass-produced drone swarms and loitering munitions seen in recent conflicts.
- Preserves expensive long-range air-defence missiles for larger threats like fighter jets, improving defence-budget efficiency.
- Developed entirely by a private Indian company under the Army's Make-II programme — a concrete 'Make in India' defence example.

📌 PRELIMS MEMORY BANK

- Developer: Solar Defence and Aerospace Ltd (SDAL), Nagpur
- Demonstrated to Army: 24 July 2026, under Make-II programme
- Detection range: 10 km (large UAVs), 6 km (small drones)
- Micro-missile range: 2.5 km; micro-rocket blast radius: ~20 m
- Trials expected to conclude: within 2-3 months of July 2026

PRACTICE MCQ · UPSC PRELIMS STYLE

Bhargavastra — Counter-Swarm Drone System Demonstrated

With reference to the Bhargavastra counter-drone system, consider the following statements:

1. It is developed by DRDO as a government-run defence research project.
2. It uses a multi-layer hard-kill approach combining unguided micro-rockets and precision-guided micro-missiles.
3. It was demonstrated to the Indian Army under the Make-II procurement programme.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Bhargavastra's development is explicitly a PRIVATE company (SDAL) building under Make-II, a category meant to encourage private-sector-led development — attributing it to DRDO conflates two distinct pillars of India's defence R&D.

② THROUGH FACTUAL KNOWLEDGE

Bhargavastra was developed by Solar Defence and Aerospace Ltd, a private company; it uses layered unguided micro-rockets and precision-guided micro-missiles; and it was demonstrated on 24 July 2026 under the Make-II programme.

GS PAPER III · DEFENCE TECHNOLOGY · MISSILE SYSTEMS (INTERNATIONAL)

Kh-101 Missile Crosses into Polish Airspace

2,500-2,800 km	Mach 0.6-0.78	~400-450 kg
Range	Speed	Warhead

NEWS IN BRIEF

- A Russian Kh-101 air-launched cruise missile crossed into Polish airspace and crashed in the Lublin Voivodeship, about 100 km from the Ukrainian border, during a massive Russian missile and drone attack on Ukraine overnight on 30 July 2026.
- Polish investigators confirmed the missile fragments were from a Kh-101 manufactured in Q2 2026 at a facility in Russia's Moscow region, with PM Donald Tusk confirming Polish forces were ready to shoot it down had it continued further.
- The overnight barrage included 74 missiles and 265 drones fired at Ukraine, comprising 61 Kh-101/Kalibr cruise missiles, 4 Zircon/Onyx missiles, and 9 ballistic Iskander-M, S-400 and KN-23 missiles — one of the largest combined strikes of the war.
- The incursion fits a pattern of Russian actions testing NATO's eastern border response, following earlier drone incursions and Russian fighter jets probing the Baltic states since late 2025.

CONCEPT SIMPLIFIED

The Kh-101 is a subsonic, air-launched cruise missile carried by Russian strategic bombers, guided by inertial navigation updated with satellite and terrain-map corrections to hit precise coordinates from long range (2,500-2,800 km). Unlike a ballistic missile arcing above the atmosphere, a cruise missile flies low and relatively slow (Mach 0.6-0.78) within the atmosphere, staying detectable longer but able to hug terrain to reduce detection.



STATIC CONNECT

Static connect — Missile Types & International Security: revise the distinction between cruise missiles (Kh-101, Kalibr) and ballistic missiles (Iskander-M, KN-23), a recurring classification tested in prelims.

UNIQUE FACT

Investigators determined the exact quarter (Q2 2026) and general facility location where the crashed Kh-101 was manufactured, just weeks after production — showing how precisely modern munitions can be forensically traced.

⚠ **EXAM TRAP —** Don't confuse the Kh-101 (subsonic cruise missile, flying within the atmosphere) with hypersonic weapons like Russia's Avangard or Zircon, which appeared in the same barrage — different categories with very different speeds and flight profiles.

RELEVANCE

- Airspace incursions by such weapons directly test NATO's collective defence readiness and decision-making speed.
- Highlights real-world vulnerability of long, contested borders to spillover from cruise missile attacks on a neighbouring country.
- Shows how forensic identification of missile fragments enables real-time geopolitical attribution and diplomatic response.

📌 PRELIMS MEMORY BANK

- Incident date: overnight, 30 July 2026
- Location: Lublin Voivodeship, Poland, ~100 km from Ukraine border
- Missile type: Kh-101, subsonic air-launched cruise missile
- Manufactured: Q2 2026, Moscow region facility
- Barrage scale: 74 missiles + 265 drones fired at Ukraine that night

PRACTICE MCQ · UPSC PRELIMS STYLE

Kh-101 Missile Crosses into Polish Airspace

With reference to the Kh-101 missile, recently in the news after an airspace incursion into Poland, consider the following statements:

1. It is a hypersonic ballistic missile that follows a high, arcing trajectory above the atmosphere.
2. It is typically launched from Russian strategic bombers such as the Tu-95MS and Tu-160.
3. It relies on inertial guidance updated with satellite and terrain-map corrections.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

A cruise missile, by definition, flies within the atmosphere rather than arcing above it like a ballistic missile — describing the Kh-101 as a high-arcing hypersonic ballistic missile misclassifies its fundamental category.

② THROUGH FACTUAL KNOWLEDGE

The Kh-101 is a subsonic air-launched cruise missile carried by Tu-95MS and Tu-160 bombers, guided by inertial navigation with satellite and terrain-map updates.

IX

SECTION

Biotechnology & Health

08 Ultra-Processed Food Linked to 67% Higher Heart Risk

09 SGLT2 Inhibitor Benefits Extend to All CKD Patients

10 Global Cholera Cases Surge in 2026

GS PAPER III · BIOTECHNOLOGY · PUBLIC HEALTH

Ultra-Processed Food Linked to 67% Higher Heart Risk

High UPF Intake (~9/day) → Independent of Calories/BP/Diabetes → 67% Higher Cardiac Risk → vs Low UPF (~1/day)

NEWS IN BRIEF

- A major US study at the American College of Cardiology's 2026 Annual Scientific Session found people eating ~9 servings of ultra-processed food (UPF) daily were 67% more likely to suffer a heart attack, stroke or related event than those eating ~1 serving — even after controlling for calories, diet quality, diabetes, blood pressure and obesity.
- Two studies in the AHA journal Hypertension (January 2026) estimated modest salt cuts in packaged bread, takeaway and processed foods in France and the UK could prevent over 1,100 deaths and around 100,000 heart disease cases plus 25,000 strokes respectively.
- A May 2026 European Heart Journal report consolidated evidence linking high UPF consumption to obesity, diabetes, hypertension, chronic kidney disease and cardiovascular death.
- Researchers say harm may not come only from salt, sugar and fat — processing itself, including emulsifiers, colourants and flavour enhancers, may independently damage cardiovascular health.

CONCEPT SIMPLIFIED

Ultra-processed foods are industrially manufactured products using ingredients rarely found in home kitchens (like emulsifiers) and processes like extrusion, engineered for taste, shelf-life and convenience — distinct from minimally processed or home-cooked food. Because they are usually energy-dense and high in salt/sugar/fat, and now suspected to carry independent harms from additives, shifting toward ultra-processed diets is linked to measurably higher cardiovascular risk.

67% higher risk — Highest UPF Group

100,000+ prevented — UK Salt Cut

1,100+ prevented — France Salt Cut

STATIC CONNECT

Static connect — Nutrition & NCDs: link to the National Multisectoral Action Plan for NCDs and India's proposed front-of-pack labelling regulations under FSSAI.

UNIQUE FACT

The 67% higher cardiovascular risk held even after researchers statistically controlled for calorie intake, diet quality, diabetes, blood pressure and obesity — suggesting processing itself plays an independent harmful role.

⚠ **EXAM TRAP —** Don't assume cardiovascular harm from ultra-processed food comes only from its known salt/sugar/fat content — 2026 findings point to processing and additives as an independent risk factor.

RELEVANCE

- Informs front-of-package warning labelling policies (like Chile's black-octagon labels) that countries, including India, are exploring.
- Guides population-level salt-reduction targets for food manufacturers, a lower-cost intervention than individual behaviour change alone.
- Relevant to India's own rising processed-food consumption and cardiovascular disease burden, especially in urban areas.

📌 PRELIMS MEMORY BANK

- Key study: ACC.26 Annual Scientific Session, published in JACC Advances
- Highest-UPF group: 67% higher risk of cardiac events
- Salt-reduction study: AHA journal Hypertension, Jan 2026 (France & UK)
- UK estimate: 17.5% salt cut could prevent 100,000+ heart disease cases
- Consolidating report: European Heart Journal, May 2026

PRACTICE MCQ · UPSC PRELIMS STYLE

Ultra-Processed Food Linked to 67% Higher Heart Risk

With reference to recent (2026) research on ultra-processed food (UPF) and cardiovascular disease, consider the following statements:

1. The elevated cardiovascular risk associated with high UPF intake disappeared once researchers controlled for calorie intake and diabetes.
2. Researchers suspect food processing and additives may independently contribute to cardiovascular harm.
3. Reducing salt in packaged and takeaway foods has been estimated to prevent thousands of cardiovascular disease cases.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The studies are notable precisely BECAUSE elevated risk persisted after controlling for calories, diabetes, blood pressure and obesity — a statement claiming the risk 'disappeared' after these controls contradicts the finding that made the research notable.

② THROUGH FACTUAL KNOWLEDGE

The 67% elevated risk persisted despite controlling for known confounders, pointing to processing/additives as independent factors; and salt-reduction modelling estimated tens of thousands of prevented cardiovascular cases.

GS PAPER III · BIOTECHNOLOGY · PUBLIC HEALTH

SGLT2 Inhibitor Benefits Extend to All CKD Patients

Blocks SGLT2 in Kidney → Glucose Excreted in Urine → Blood Sugar Lowered → Kidney & Heart Protected

NEWS IN BRIEF

- A study from Oxford University's Nuffield Department of Population Health, reported 29 July 2026, found the kidney and heart benefits of SGLT2 inhibitor drugs extend to essentially all chronic kidney disease (CKD) patients, not just narrower subgroups previously prioritised.
- With SGLT2 inhibitors like dapagliflozin now available as generics, researchers say extending treatment to all eligible CKD patients could substantially advance WHO's global kidney-health goals at comparatively low cost.
- Earlier in 2026, the American Diabetes Association's updated guidance recommended considering SGLT2 inhibitors from the point of type 2 diabetes diagnosis, reflecting their reclassification as disease-modifying therapies rather than optional add-ons.
- The UK's NICE widened access to SGLT2 inhibitors in February 2026, projecting the change could prevent around 17,000 deaths over three years, aided by dapagliflozin's generic status saving the NHS an estimated £560 million.

CONCEPT SIMPLIFIED

SGLT2 is a protein in the kidney's filtering tubules that normally reabsorbs glucose back into the blood after filtration. SGLT2 inhibitor drugs block this protein, causing excess glucose to be excreted in urine instead — lowering blood sugar directly, while separately reducing pressure and strain within the kidney's filtering units, protecting kidney and heart function even in people without diabetes.

~17,000/3yrs	£560 million	Nearly all CKD
UK Deaths Preventable	NHS Savings	Eligible Group

STATIC CONNECT

Static connect — Human Excretory System: revise the nephron's filtration and reabsorption process from NCERT Biology, linked to India's rising CKD and diabetes burden as a public health theme.

UNIQUE FACT

SGLT2 inhibitors were originally developed purely as diabetes drugs, but are now recommended for kidney and heart protection even in patients without diabetes at all — an unusually broad expansion of a drug's approved use.

⚠ **EXAM TRAP —** Don't assume SGLT2 inhibitors only benefit people with diabetes — 2026 findings confirm kidney and cardiovascular benefits extend broadly to CKD patients regardless of diabetes status.

RELEVANCE

- Offers a single, low-cost drug class that simultaneously manages diabetes, protects kidney function and reduces heart failure risk.
- Broadening eligibility to nearly all CKD patients could meaningfully cut kidney-failure and cardiovascular death rates at population scale.
- Its generic availability makes it a realistic public health intervention for resource-constrained health systems, relevant to India's large CKD burden.

📌 PRELIMS MEMORY BANK

- Latest finding: Oxford study, 29 July 2026 — benefits extend to nearly all CKD patients
- Drug examples: dapagliflozin, empagliflozin, canagliflozin
- ADA 2026: recommends SGLT2 inhibitors from point of T2D diagnosis
- NICE UK: widened access Feb 2026; ~17,000 deaths preventable over 3 years
- Mechanism: blocks glucose reabsorption in kidney tubules

PRACTICE MCQ · UPSC PRELIMS STYLE

SGLT2 Inhibitor Benefits Extend to All CKD Patients

With reference to SGLT2 inhibitor drugs, consider the following statements:

1. They lower blood sugar by blocking glucose reabsorption in the kidney, causing it to be excreted in urine.
2. Their kidney and cardiovascular benefits are limited strictly to patients who also have diabetes.
3. A 2026 Oxford study found their benefits extend to nearly all chronic kidney disease patients.

Which of the statements given above is/are correct?

(a) 1 and 3 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 1 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

The 2026 research is notable for showing benefits extending BEYOND diabetics to the broader CKD population — a statement restricting benefits strictly to diabetics contradicts the headline finding driving 2026's guideline changes.

② THROUGH FACTUAL KNOWLEDGE

SGLT2 inhibitors block glucose reabsorption in kidney tubules; and the July 2026 Oxford study found their kidney and heart benefits extend to essentially all CKD patients, not just those with diabetes.

GS PAPER III · BIOTECHNOLOGY · PUBLIC HEALTH

Global Cholera Cases Surge in 2026

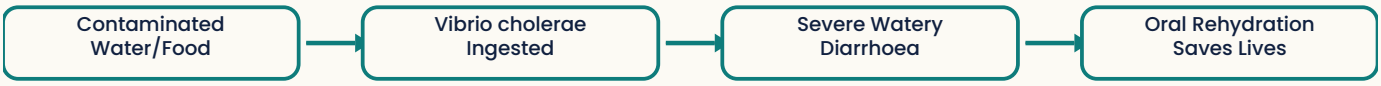
29,610 (+43%)	1,200+	~200 deaths
May 2026 Cases	2026 YTD Deaths	Nigeria (Borno)

NEWS IN BRIEF

- WHO reported a sharp rise in global cholera and acute watery diarrhoea cases in 2026, with 29,610 new cases across 16 countries in May 2026 alone — a 43% increase over April 2026.
- Nigeria's Borno state recorded nearly 200 deaths from a worsening cholera outbreak over two months as of late July 2026, with MSF treating over 24,000 suspected patients, attributing spread to inadequate clean water, sanitation and healthcare access.
- Since 1 January 2026, over 105,000 cholera cases and 1,200+ deaths have been reported worldwide (as of late June 2026), with Nigeria, DR Congo and Angola reporting the highest case counts.
- Conflict-affected Sudan has also reported a deadly outbreak (100+ deaths, 1,330+ confirmed cases as of mid-July 2026), with WHO warning the ongoing rainy season is likely to worsen the situation.

CONCEPT SIMPLIFIED

Cholera is an acute diarrhoeal infection caused by the bacterium Vibrio cholerae (serogroups O1 or O139), typically spread through water or food contaminated with faecal matter. It causes severe watery diarrhoea and rapid dehydration that can be fatal within hours if untreated, but is both preventable (clean water and sanitation) and highly treatable (oral rehydration therapy), making most deaths a reflection of failed WASH infrastructure rather than the disease's inherent lethality.



STATIC CONNECT

Static connect — Water-Borne Diseases & WASH: revise cholera's transmission and prevention alongside other water-borne diseases (typhoid, dysentery), linked to India's WASH infrastructure missions.

UNIQUE FACT

The May 2026 monthly global case count (29,610 in one month) represented a 43% jump over the previous month, showing how quickly this preventable disease can surge when water and sanitation systems break down.

⚠ **EXAM TRAP —** Don't assume cholera is primarily deadly because it's hard to treat — most deaths occur due to delayed access to simple oral rehydration therapy, not because the disease lacks an effective, low-cost treatment.

RELEVANCE

- Cholera outbreaks are a direct, measurable indicator of a region's water, sanitation and hygiene (WASH) infrastructure failures.
- Rapid oral cholera vaccine deployment and oral rehydration therapy remain the primary low-cost tools for outbreak response.
- India's own Swachh Bharat Mission and Jal Jeevan Mission are directly relevant to preventing similar outbreaks domestically.

📌 PRELIMS MEMORY BANK

- Global cases (2026 YTD, to June): 105,000+ cases, 1,200+ deaths
- May 2026 monthly cases: 29,610 (43% rise over April)
- Nigeria (Borno): ~200 deaths, 24,000+ treated (2 months, to July 2026)
- Sudan: 1,330+ cases, 114+ deaths (to mid-July 2026)
- Causative agent: Vibrio cholerae (serogroups O1/O139)

PRACTICE MCQ · UPSC PRELIMS STYLE

Global Cholera Cases Surge in 2026

With reference to the global cholera situation in 2026, consider the following statements:

1. Cholera is caused by a viral pathogen transmitted primarily through airborne droplets.
2. Global cholera cases rose sharply in May 2026 compared to the previous month.
3. Oral rehydration therapy is a primary low-cost treatment for cholera.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

Cholera's textbook classification is a BACTERIAL infection spread through contaminated water or food, not an airborne virus — conflating it with an airborne viral disease misattributes both its pathogen type and transmission route.

② THROUGH FACTUAL KNOWLEDGE

Cholera is caused by the bacterium Vibrio cholerae, spread via contaminated water/food; WHO recorded a 43% rise in global cases in May 2026; and oral rehydration therapy remains a primary, low-cost, effective treatment.

SECTION

ICT & Emerging Tech

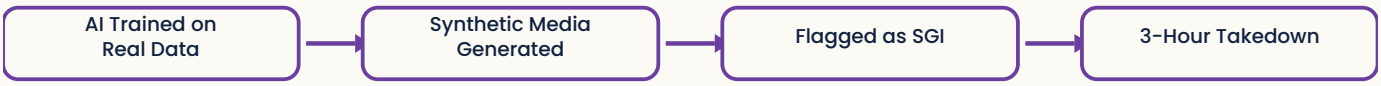
11 India Moves to Criminalise Deepfakes

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13 AlphaFold 3 Reshapes Drug Discovery

GS PAPER II/III · DIGITAL GOVERNANCE · EMERGING TECH

India Moves to Criminalise Deepfakes



NEWS IN BRIEF

- India's Supreme Court was told on 29 July 2026 that the government is considering a new law during the ongoing Parliament session to make deepfakes and 'digital arrest' scams distinct criminal offences with defined punishments, per Solicitor General Tushar Mehta.
- This follows the IT Rules 2026 amendments (notified February 2026), which introduced a 3-hour takedown window for flagged 'Synthetically Generated Information' (SGI) and mandatory AI-content labelling — a sharp cut from the earlier 36-hour window.
- The push comes amid a surge in deepfake videos impersonating top military officers and other public figures, raising concerns about misinformation during periods of geopolitical tension.
- The proposed law would also target 'digital arrest' scams, where fraudsters pose as police or government officials over video calls to intimidate victims into transferring money.

CONCEPT SIMPLIFIED

A deepfake is synthetic audio, video or image content generated or altered by AI to convincingly impersonate a real person's face, voice or actions. Because generative AI models learn patterns from vast amounts of real data, they can now synthesise highly realistic fake media that is difficult to distinguish from genuine recordings, especially at speed and scale.

36 hrs	3 hrs	Feb 2026
Old Takedown	New Takedown	Rules Notified

STATIC CONNECT

Static connect — IT Act & Digital Governance: link to the IT Act, 2000's intermediary liability/safe harbour framework and India's broader Digital India regulatory architecture.

UNIQUE FACT

India's new IT Rules compress the takedown window for flagged deepfakes to just 3 hours — down from the earlier 36-hour window — among the fastest such requirements globally.

⚠ **EXAM TRAP —** Don't confuse the IT Rules 2026 amendments (regulatory takedown/labelling framework, already in force) with the proposed new criminal law on deepfakes (still under consideration as of July 2026, not yet enacted) — two distinct, sequential steps.

RELEVANCE

- Direct real-world harm includes financial fraud via voice-cloned scam calls, reputational damage, and impersonation of officials to spread disinformation.
- Platforms must build technical detection and labelling systems into content pipelines, changing how social media and OTT platforms operate in India.
- Creates a template other countries can study for balancing free expression with rapid content moderation in the AI era.

📌 PRELIMS MEMORY BANK

- IT Rules amendment notified: 10 February 2026, effective 20 Feb 2026
- New takedown window: 3 hours (down from 36 hours)
- New term: 'Synthetically Generated Information' (SGI)
- New law proposed: July 2026, to criminalise deepfakes & digital arrest scams
- Regulator: MeitY (Ministry of Electronics & IT)

PRACTICE MCQ · UPSC PRELIMS STYLE

India Moves to Criminalise Deepfakes

Consider the following statements regarding India's regulatory response to deepfakes:

1. The IT Rules 2026 amendments increased the content takedown window from 3 hours to 36 hours.
2. 'Synthetically Generated Information' is a term formally recognised under the amended IT Rules.
3. As of July 2026, Parliament had already passed a standalone law making deepfakes a distinct criminal offence.

Which of the statements given above is/are correct?

(a) 2 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

A regulatory tightening aimed at faster removal of harmful content would logically SHORTEN the takedown window, not lengthen it — the reported change (36 hours to 3 hours) is a reduction. Since the government told the Supreme Court it was still 'considering' a new law as of 29 July 2026, claiming Parliament had already passed it overstates the process.

② THROUGH FACTUAL KNOWLEDGE

The IT Rules 2026 amendment cut the takedown window from 36 hours to 3 hours; it formally defines 'Synthetically Generated Information'; and the standalone criminal law on deepfakes remained a proposal, not yet passed, as of late July 2026.

GS PAPER III · ICT · AI HARDWARE

Google Splits Its TPU Line for the Agentic AI Era

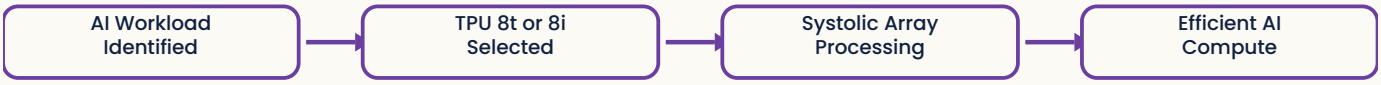
3x faster	~80% better	1M+ TPUs
Training Speed	Perf/Dollar	Max Cluster

NEWS IN BRIEF

- Google Cloud unveiled its eighth-generation Tensor Processing Units (TPUs) in April 2026, splitting the line into two specialised chips for the first time: TPU 8t for AI model training and TPU 8i for inference.
- The new chips offer up to 3x faster AI model training, about 80% better performance per dollar, and the ability to link over 1 million TPUs together in a single cluster — Google's latest move to compete with Nvidia's GPUs.
- In a further shift, Google announced in mid-2026 it will begin selling TPU hardware directly to a select group of customers for their own data centres, rather than only offering remote cloud access, with Anthropic reportedly a major customer at scale.
- Google Cloud posted over $20 billion in Q1 2026 revenue (63% higher year-on-year), with a $460 billion backlog of undelivered contracts, reflecting surging global demand for AI computing infrastructure.

CONCEPT SIMPLIFIED

A TPU is an Application-Specific Integrated Circuit (ASIC) — a chip custom-built for one job, unlike general-purpose CPUs or even GPUs. TPUs are purpose-designed for the matrix and tensor mathematics underlying neural network training and inference, using a 'systolic array' architecture that lets data flow through many small processing units in a tightly coordinated pipeline, making them more power-efficient for AI workloads than general-purpose chips.



STATIC CONNECT

Static connect — Emerging Tech & Semiconductors: link to India's own semiconductor and AI compute ambitions (India Semiconductor Mission, IndiaAI Mission's GPU/compute allocation) as a comparative case.

UNIQUE FACT

Google's new TPU cluster architecture can link more than 1 million individual chips together to work as a single coordinated AI supercomputer.

⚠ **EXAM TRAP —** Don't confuse a TPU (Google's custom AI ASIC) with a GPU (general-purpose graphics chip, Nvidia's core product) — both accelerate AI workloads, but TPUs are purpose-built exclusively for tensor/matrix operations.

RELEVANCE

- Powers Google's own large-scale AI products (Search, Gemini, Photos, Maps) as well as external cloud customers renting TPU compute.
- Splitting training and inference chips reflects a broader trend: as 'agentic AI' demands more real-time inference at scale, chip design is specialising by workload.
- Direct hardware sales signal AI compute becoming a tradable commodity, relevant to countries (including India) building sovereign AI compute capacity.

📌 PRELIMS MEMORY BANK

- New chips: TPU 8t (training), TPU 8i (inference) — announced April 2026
- Performance gain: up to 3x faster training, ~80% better performance/dollar
- Cluster scale: 1 million+ TPUs linked together
- New move: Google selling TPU hardware directly to select customers (2026)
- Q1 2026 Cloud revenue: $20 billion+ (63% YoY growth)

PRACTICE MCQ · UPSC PRELIMS STYLE

Google Splits Its TPU Line for the Agentic AI Era

With reference to Google's Tensor Processing Units (TPUs), consider the following statements:

1. TPUs are general-purpose processors designed to perform a wide variety of unrelated computing tasks.
2. Google's eighth-generation TPU line was split into separate chips for training and inference.
3. As of 2026, Google has begun selling TPU hardware directly to select external customers.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

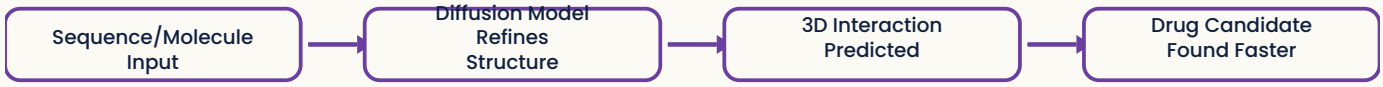
A TPU is a chip purpose-built for tensor/matrix mathematics specific to neural networks — the very definition of an ASIC is that it is NOT general-purpose, so a statement calling it general-purpose contradicts its basic design philosophy.

② THROUGH FACTUAL KNOWLEDGE

TPUs are application-specific chips for AI workloads; Google split its eighth-generation line into TPU 8t (training) and TPU 8i (inference) in April 2026; and Google announced plans to sell TPU hardware directly to select customers in 2026.

GS PAPER III · ICT/BIOTECHNOLOGY · AI IN SCIENCE

AlphaFold 3 Reshapes Drug Discovery



NEWS IN BRIEF

- Google DeepMind and Isomorphic Labs released AlphaFold 3's source code and model weights for academic use in November 2024, sparking a wave of drug-discovery activity through 2025-26.
- Unlike AlphaFold 2 (single-protein structures only), AlphaFold 3 uses a diffusion-based architecture to model how proteins interact with DNA, RNA, other molecules and ions as one unified system.
- Isomorphic Labs has used AlphaFold 3 to secure multi-billion-dollar partnerships with pharma giants like Eli Lilly and Novartis, moving several AI-designed drug candidates into Investigational New Drug (IND)-enabling stages, with the first AlphaFold 3-designed drugs expected to enter human clinical trials by the end of 2026.
- The AlphaFold Database has grown to around 200 million predicted protein structures, updated in March 2026 to include homodimers, while rival open-source efforts like OpenFold3 released competing models and training data the same month.

CONCEPT SIMPLIFIED

AlphaFold 3 uses a 'diffusion' architecture — the same broad technique behind AI image generators — starting from random noise and iteratively refining it into an accurate 3D structure, rather than directly calculating atomic coordinates in one step. This lets it flexibly model many biomolecule types and their interactions within one unified system, instead of needing separate specialised tools for each molecule type.

~200M structures	~40% (2024-25)	End of 2026
AlphaFold DB	New PDB via AF	Trials Expected

STATIC CONNECT

Static connect — Biotechnology & AI Convergence: revise protein structure basics from NCERT Biology and link to India's BioE3 policy and IndiaAI Mission.

UNIQUE FACT

About 40% of new protein structures added to the global Protein Data Bank between 2024 and 2025 were generated using AlphaFold-based prediction rather than traditional lab techniques like X-ray crystallography.

⚠ **EXAM TRAP —** Don't confuse AlphaFold 2 (predicts a single protein's own structure) with AlphaFold 3 (predicts how proteins interact with DNA, RNA and other molecules) — a frequently tested version-specific distinction.

RELEVANCE

- Compresses the 'hit-to-lead' phase of drug discovery from years to months, by predicting how a candidate molecule binds to its target before lab synthesis.
- Enables research into biorenewable materials, more resilient crops and genomics, not just pharmaceuticals.
- The 2024 Nobel Prize in Chemistry for the AlphaFold approach has driven pharma industry investment in AI-native biotech, restructuring the discovery pipeline.

📌 PRELIMS MEMORY BANK

- Released for academic use: November 2024 (code & weights)
- Predicts: proteins, DNA, RNA, ligands, ions and their interactions
- Architecture: diffusion-based (unlike AlphaFold 2's Evoformer)
- AlphaFold Database size: ~200 million predicted structures
- Nobel Prize link: 2024 Chemistry Nobel (Hassabis & Jumper)

PRACTICE MCQ · UPSC PRELIMS STYLE

AlphaFold 3 Reshapes Drug Discovery

With reference to AlphaFold 3, consider the following statements:

1. It can only predict the structure of individual proteins in isolation, like its predecessor AlphaFold 2.
2. It uses a diffusion-based architecture to model biomolecular interactions.
3. Its underlying approach to protein structure prediction was linked to a Nobel Prize in Chemistry.

Which of the statements given above is/are correct?

(a) 2 and 3 only

(b) 1 and 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

✓ **Correct Answer: (a) 2 and 3 only**

SOLUTION EXPLAINED

① THROUGH LOGICAL ANALYSIS

AlphaFold 3's defining upgrade over AlphaFold 2 is precisely moving BEYOND single-protein prediction to model interactions with DNA, RNA and other molecules — a statement claiming it is limited like AlphaFold 2 erases the distinction that makes it a new version.

② THROUGH FACTUAL KNOWLEDGE

AlphaFold 3 uses a diffusion-based architecture to predict multi-molecule interactions; and the protein structure prediction approach behind AlphaFold won the 2024 Nobel Prize in Chemistry.