Tardigrades Aboard Axiom-4 Mission to Test Space Resilience

Source: IE

Why in News?

Indian astronaut, **Shubhanshu Shukla**, will pilot the **Axiom-4 mission** to the **International Space Station (ISS)** while **Peggy Whitson (USA)** will **command** the mission.

- As a part of the mission, ISRO is sending **tardigrades (water bears)**—microscopic, hardy organisms—to the **ISS** to study how life can survive in **extreme space conditions.**

What is the Axiom-4 Mission?

- **About: Axiom Mission 4 (Ax-4)** is the **4th private spaceflight to the ISS**, operated by **Axiom Space**, a US-based space company, using the **SpaceX Crew Dragon** spacecraft.
  - With this, **Shubhanshu Shukla** will become the **2nd Indian** to travel to **space** (after **Rakesh Sharma** in 1984) and the **1st Indian** to set foot on the **ISS.**
- **Key Features: Axiom Space's 14-day mission aboard the ISS** will conduct **scientific experiments**, **tech demonstrations**, and **educational outreach**, advancing its goal to build the **first commercial space station** and transition from **ISS reliance to an independent orbital platform.**
  - It features an **international crew** comprising members from the **United States, India, Poland, and Hungary.**
- **Key Experiment:**
  - **Physical and cognitive impact** of using computer screens in microgravity.
  - **Behaviour and response of tardigrades** (water bears) in space
  - Impact of spaceflight on **six varieties of crops** specifically on **moong dal**.
  - Growth rate, cellular responses, and biochemical activity of **cyanobacteria** (a group of bacteria that are known to produce energy through **photosynthesis** just like plants).
- **Significance for India: Strengthens Indo-US space collaboration** through **ISRO-NASA partnership** while conducting **10 critical experiments** (*microgravity*, *seed growth*, *tardigrade studies*) to validate research for **Gaganyaan mission (2027).**
  - Boosted the success of **Gaganyaan mission** by providing **hands-on experience** for **Gaganyaan crew training**, advancing **astrobiology research**, and positioning India as a key player in future **commercial space stations**.

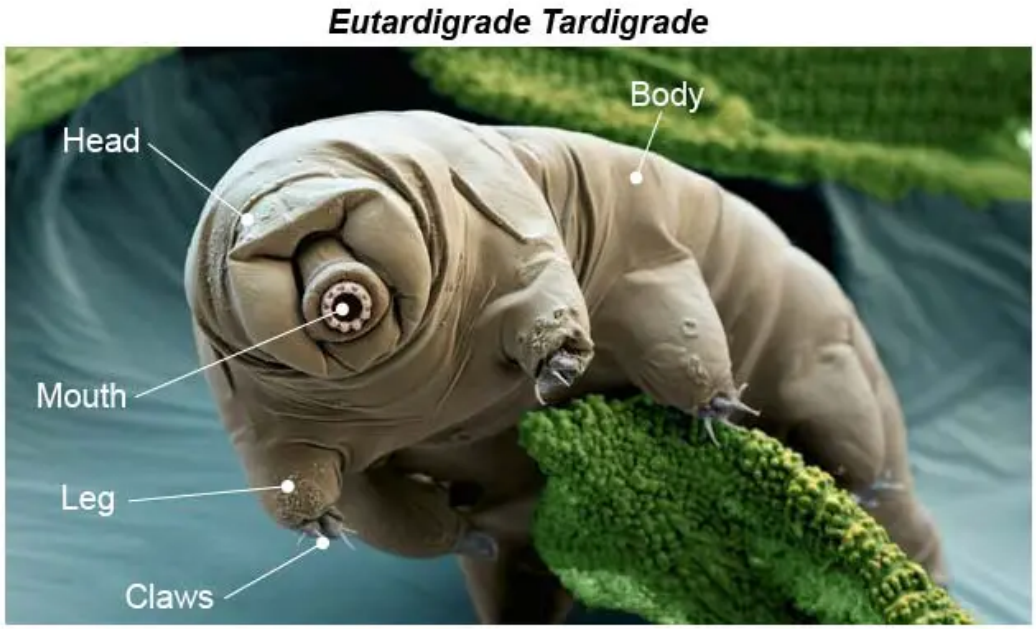
Note: Zero-G indicator is a **small item**, often a plushie (soft, stuffed toy), that provides astronauts a **visual cue** that they have entered a **state of weightlessness**. The zero-G indicator for the Axiom-4 mission is a **swan plushie named 'Joy'.**

What are Key Points About Tardigrades?

- **About: Tardigrades** (also known as **water bears** or **moss piglets**) are **microscopic, eight-legged organisms** about **0.5 mm** long that feed on plant and algae fluids.
    - They've existed for **~600 million years** and **survived all five mass extinctions**, making them one of the **most resilient life forms on Earth**.
    - They are found in **diverse moist habitats**—from mountaintops to deep seas—and are known for their **extreme durability.**
- **Survival Abilities: Tardigrades** can **survive extreme conditions**—from **temperatures of –272.95°C to 150°C**, intense **UV radiation**, **vacuum of space**, and **pressures up to 40,000 kilopascals**, even **reviving after 30 years in frozen states.**
- **Survival Mechanisms:**
    - **Cryptobiosis:** Near-complete **metabolic shutdown** in harsh conditions.
    - **Anhydrobiosis:** Reduces water content by **>95%**, entering a durable **shrunken state** called **tun**.
    - **Unique Proteins (CAHS): Cytoplasmic-abundant heat soluble (CAHS)** proteins form a **protective gel** within their cells, protecting essential cellular components from destruction.
- **Scientific Importance:** Research on tardigrades could lead to **climate-resilient crops**, **advanced UV-protective sunscreens**, and **improved organ preservation techniques** for transplants.
- **Space Survivors:** Tardigrades made history in **2007** as the **first animals to survive direct exposure to space** during **ESA's Foton-M3 mission**, proving their extraordinary resilience beyond Earth's atmosphere.

Note: Batillipes chandrayaani is a newly discovered species of **marine tardigrade** found along India's southeast coast of **Tamil Nadu**.

- It was named in honour of **India's Chandrayaan-3 moon mission**, reflecting a symbolic connection between India's advancements in **space exploration and marine biology.**



UPSC Civil Services Examination, Previous Year Question (PYQ)

Q. Consider the following space missions: (2025)

1. Axiom-4
2. SpaDeX
3. Gaganyaan

How many of the space missions given above encourage and support microgravity research?

(a) Only one

(b) Only two

(c) All three

(d) None

Answer: (c)

Q. Consider the following statements: (2016)

The Mangalyaan launched by ISRO

1. is also called the Mars Orbiter Mission
2. made India the second country to have a spacecraft orbit the Mars after USA
3. made India the only country to be successful in making its spacecraft orbit the Mars in its very first attempt

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans: (c)