Zebrafish and its Importance in Human Spaceflights

Why in News

A new research in **zebrafish** has demonstrated how **induced hibernation (torpor)** may protect humans from the elements of space, especially radiation, during space flight.

Key Points

About the Study:

- The researchers **exposed zebrafish to radiation** like what would be experienced on a six-month journey to Mars.
  - They observed signs of oxidative stress **(imbalance between antioxidants and free radicals)**, DNA damage, stress hormone signaling and changes to the cell-division cycle.
- The researchers then **induced torpor in a second group of zebrafish** which were then exposed to the same dose of radiation.
  - The results showed that **torpor lowered the metabolic rate within the zebrafish and created a radioprotective effect**, protecting against the harmful effects of radiation.
  - Torpor, **a form of hibernation**, is a brief spell of suspended animation. It usually lasts less than a day. When in torpor, an animal's metabolism, heartbeat, breathing, and body temperature are greatly reduced.

Zebrafish

- **Scientific Name:** *Danio rerio*
- **Habitat:**
  - It is a small (2-3 cm long) freshwater fish found in the **tropical and subtropical regions.** The fish is native to **South Asia's Indo-Gangetic plains**, where they are mostly found in the paddy fields and even in stagnant water and streams.
  - They are classified as a **species of least concern** on the **IUCN's Red List of Threatened Species.**

- **Organism for Biomedical Research:**
  - They have been used to study vertebrate development, evolution, genetics, and disease due to its adequate **regeneration capacity of almost all its organs**, including the brain, heart, eye, spinal cord.
  - Zebrafish have a **similar genetic structure** (around 70%) to humans.
  - As a vertebrate, the zebrafish has the same major organs and tissues as humans. Their muscle, blood, kidney and eyes share many features with human systems.

- **Need of the Study:**

  Recent technological advancements might have made space travel more accessible. However, long-term space travel is incredibly **detrimental to human healt**h.
- **Significance:**
  - The study could help in understanding how a form of **hibernation, known as induced torpor (a state of reduced metabolic activity)** may provide radio-protective effects.
    - Hibernation is a physiological condition found in many species.
    - It **protects them against harsh conditions**, such as food scarcity and low environmental temperatures.
  - Replicating hibernation may therefore **protect astronauts** against the **harsh conditions of space flight**, which include challenges such as **radiation exposure, bone and muscle wastage, advanced ageing and vascular problems.**
  - The **European Space Agency (ESA)** is also conducting research into the impacts of **hibernating astronauts not just for health reasons**, but because it could **reduce the amount of consumables required for a space journey** and allow the **mass of a spacecraft to be reduced by a third.**

Challenges of Space Travel

- **Radiation:**
  - Any space flight is outside **Earth's protective magnetic field**, where radiation is much higher as compared to International space stations. (International space station is just within the earth's protective atmosphere; even then radiation is 10 times higher when compared to earth.)
  - **Radiation exposure** increases **cancer risk, damages the central nervous system, can alter cognitive function, reduce motor function and prompt behavioural changes.**

- **Isolation and Confinement:**
  - **Behavioural issues** among astronauts crammed in a small space over a long period of time, are inevitable.
  - Sleep loss, circadian desynchronization, and work overload compound this issue and may lead to performance decrements, adverse health outcomes.
- **Distance from Earth:**

  As distance of space flight increases from earth, communication delay increases. For example, there will be a communication delay of 20 minute in space travel to Mars.
- **Gravity:**
  - Different planets have **different gravitational pull**, for example astronauts would need to live and work in three-eighths of Earth's gravitational pull on Mars. Additionally, explorers will experience total weightlessness during the course of travel.
  - To further complicate the problem, when astronauts transition from one gravity field to another, it's usually quite an intense experience.
  - Blasting off from the surface of a planet or a descent through an atmosphere is many times the force of gravity.
- **Hostile/Closed Environments:**

  NASA has learned that the **ecosystem inside the spacecraft** plays a big role in everyday astronaut life. Microbes can change characteristics in space, and microorganisms that naturally live on your body are transferred more easily from person to person in closed habitats like the space station.

Source: DTE