India’s Nuclear Programme

Source: IE

Why in News?

Eminent physicist, scientist, former Chairman of the **Atomic Energy Commission (AEC)** and a **key architect of India’s nuclear** programme **Dr. Rajagopala Chidambaram** recently passed away.

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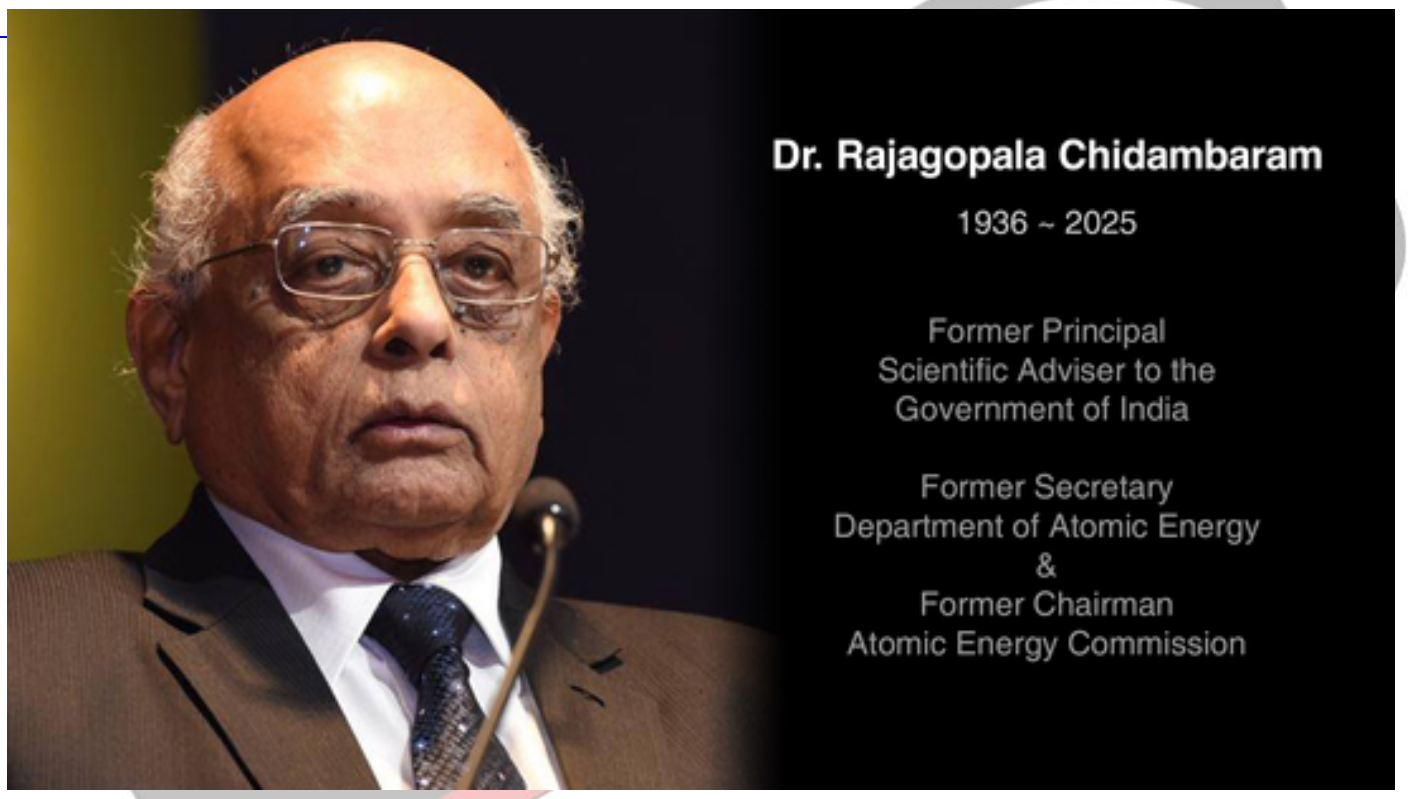

Key Contributions of Dr. Rajagopala Chidambaram

- **Scientific Achievements**: Solved the **"equation of state"** for plutonium (1967), advancing nuclear fission and **materials science.**
    - Led India’s indigenous **supercomputer** development.
- **Leadership in Nuclear Tests**: **Smiling Buddha (1974)** and **Operation Shakti (1998).**
- **Key Positions**: Director of **BARC**, Chairman of **Atomic Energy Commission (AEC)**, Chairman of **IAEA** Board of Governors.
    - Principal Scientific Advisor (2002-2018), overseeing initiatives like **RuTAG** and **National Knowledge Network (NKN).**
- **Awards**: **Padma Shri (1975)** and **Padma Vibhushan (1999)** for contributions to science.

What is India's 3-Stage Nuclear Power Programme?

- **About:** India's **3-Stage Nuclear Power Programme** is designed to harness the nation's nuclear resources for sustainable energy production while **ensuring long-term energy security.** It was formulated by well-known physicist **Dr. Homi Bhabha**.
- **Objective:** It focuses on **efficiently using India's limited uranium resources** while **maximizing the potential of thorium**, which is more abundant in the country.
- **3 Stages:**

Stage	Aim	Fuel/Coolant/ Moderator	Nuclear Reactor	Current Status
Stage 1	It aims to generate electricity while **producing plutonium-239 (Pu-239)** as a byproduct. ▪ Plutonium is key for the next stages of the	Fuel: **Uranium (U-238)** Moderator: **Heavy water (deuterium oxide)**	Pressurized Heavy Water Reactors (PHWRs)	India has already constructed 18 PHWRs, as the foundation of India's nuclear power infrastructure.
Stage 2	It focuses on **Fast Breeder Reactors (FBRs)**, which utilize **Pu-239** from the first stage to generate more fissile material than they consume. ▪ These reactors convert **fertile uranium-238** into **Pu-239**, enhancing the nuclear fuel cycle efficiency and providing a sustainable fuel source.	Mixed Oxide of **Plutonium-239 and Uranium-238**	Fast Breeder Reactors (FBRs)	The **Prototype FBR** at **Kalpakkam, Tamil Nadu**, is a key development in this stage.
Stage 3	It focuses on **Thorium Reactors**, which use **Thorium-232** to produce	**Thorium-232** (converted into Uranium-233)	Thorium-Based Reactors (Thorium Cycle)	Research into thorium-based reactors is ongoing, with the **Advanced Heavy Water Reactor**

	uranium-233, a fissile material. ▪ Leveraging India's abundant thorium reserves, this stage offers a long-term solution for nuclear fuel needs, ensuring sustainable energy security.			**(AHWR)** being developed as part of this stage.

India Nuclear Weapon Programme

- **Smiling Buddha (1974)**: **Smiling Buddha** was the codename of India's **first successful nuclear test**, conducted at **Pokhran** in Rajasthan, marking India as the **sixth nuclear-capable nation** after the **US, Soviet Union, United Kingdom, France,** and **China.**
- **Operation Shakti (1998)**: **Operation Shakti** **(Pokhran-II)** was a series of **five nuclear tests** under **Operation Shakti**, including a **thermonuclear bomb**.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. In India, why are some nuclear reactors kept under "IAEA safeguards" while others are not? (2020)

(a) Some use uranium and others use thorium

(b) Some use imported uranium and others use domestic supplies

(c) Some are operated by foreign enterprises and others are operated by domestic enterprises

(d) Some are State-owned and others are privately owned

Ans: (b)