Science & Technology · GS - III

Give an account of the growth and development of nuclear science and technology in India. What is the advantage of fast breeder reactor programme in India?

EXAM YEAR	PAPER	SUBJECT
2017	GS - III	Science & Technology

MARKS	WORD LIMIT
15	~250 words

Answer Hint

Nuclear research; Bhabha Atomic Research Centre; three-stage programme; energy security; fast breeder reactors; thorium utilisation; nuclear safety

Model Answer

Introduction

India developed nuclear science and technology to support energy security, scientific research, medicine, agriculture and strategic requirements. Its nuclear programme has evolved around indigenous capabilities and long-term utilisation of domestic thorium resources.

Growth and Development of Nuclear Science and Technology

- **Institutional foundations:** The Atomic Energy Commission was established in 1948, followed by the Department of Atomic Energy in 1954.
- **Research infrastructure:** The establishment of the Bhabha Atomic Research Centre strengthened research in reactors, materials and nuclear applications.
- **Nuclear power:** Reactors at Tarapur, Rajasthan and other locations expanded electricity-generation capacity.
- **Three-stage programme:** India developed a long-term strategy involving natural uranium, plutonium-based fast breeder reactors and thorium-based systems.

- **Peaceful applications:** Nuclear techniques support cancer treatment, medical diagnostics, agriculture, food preservation and industrial applications.
- **International cooperation:** Civil nuclear agreements and safeguards arrangements have broadened access to technology and fuel.

Advantages of the Fast Breeder Reactor Programme

- **Fuel utilisation:** Fast breeder reactors can produce more fissile material than they consume under suitable conditions.
- **Resource efficiency:** They can utilise plutonium recovered from spent fuel, supporting India's long-term nuclear strategy.
- **Thorium pathway:** Breeding fissile material can help support eventual utilisation of India's substantial thorium resources.
- **Energy security:** Greater fuel utilisation can reduce pressure on limited uranium resources.
- **Technological capability:** The programme strengthens indigenous expertise in advanced nuclear engineering.

Challenges

High capital costs, complex technology, radioactive waste management, fuel-cycle safeguards and safety requirements demand rigorous oversight.

Conclusion

Nuclear science has strengthened India's scientific and energy capabilities. Fast breeder technology offers potential long-term fuel advantages, provided safety, economic viability and waste management are addressed.

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