

PARLIAMENT QUESTION: NUCLEAR TECHNOLOGY IN MEDICAL AND AGRICULTURAL SECTORS

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Department of Atomic Energy (DAE) is advancing the peaceful applications of nuclear technology in the medical and agricultural sectors.

Nuclear technology in Medical Sector:

In medical sector, nuclear medicine and radioisotopes are extensively used for diagnostic and therapeutic applications, especially in cancer care.

Bhabha Atomic Research Centre (BARC) a constituent Unit of DAE, regularly produces radioisotopes and ready-to-use radiopharmaceuticals, which are supplied through Board of Radiation & Isotope Technology (BRIT) an industrial sector of DAE, to nuclear medicine centres across India, thereby supporting timely availability for diagnostic and therapeutic applications. DAE has taken significant efforts towards indigenous development of radiopharmaceuticals and allied products, with the objective of providing cost-effective alternatives to imported radiopharmaceuticals.

Radioisotopes are indigenously produced through research reactors and cyclotrons. Radioisotopes such as Ruthenium-106, Caesium-137, and Strontium-90 milked into Yttrium-90, are recovered through the reprocessing of high-level liquid waste (HLLW).

DAE is also contributing to the field of nuclear medicine through its clinical patient services units at the Radiation Medicine Centre (RMC), Mumbai, and the Radiation Medicine Research Centre (RMRC), Kolkata, which provide diagnostic and therapeutic services for cancer treatment. RMRC, Kolkata is a state-of-the-art nuclear medicine facility established in the Eastern Region under the aegis of BARC, Mumbai. The Centre has been operational since January 2024 and provides advanced and affordable diagnostic and therapeutic nuclear medicine services to patients from the Eastern and North-Eastern regions of India.

Over the past several years, DAE has developed several key nuclear medicine ligands and targeted therapeutics as part of the national effort to combat cancer, especially in the areas of advanced treatment and research. DAE has developed peptide-based ligand, PSMA-617 for use in prostate cancer therapy. The in-house developed nuclear medicine ligand ^{177}Lu -PSMA-617 is regularly supplied through BRIT to hospitals across India. Recently, DAE has developed another nuclear medicine ligand, PSMA-11, as an import substitute for production of ^{68}Ga -PSMA11, which is used in the diagnosis of prostate cancer.

Radioactive Pharmaceuticals such as Ga68 DOTANOC, Ga68 FAPI, 18F FDG are used for evaluation of various cancers such as prostate cancer, Neuroendocrine Tumors, Mucinous, Signet GI cancers, carcinoma lung, carcinoma oesophagus, breast cancer, lymphoma, etc.

DAE manufactures and supplies approximately 18 different types of cold kits for the preparation of Technetium-99m radiopharmaceuticals, which are widely used for early diagnosis of diseases affecting nearly all major organs of the body, including various types of cancers. These kits enable the formulation of high-quality diagnostic radiopharmaceuticals based that play a key role in the early detection, staging, and monitoring of a broad spectrum of diseases in nuclear medicine.

DAE has also developed a synthesis protocol for affordable, sesta-MIBI, which is regularly used as 99mTc-MIBI for cardiac imaging.

A list of radioisotopes and radiopharmaceutical products made available in India since 2014, along with their clinical applications, is given below:

DAE-RPC APPROVED RADIOPHARMACEUTICALS AND ALLIED PRODUCTS		
Sl. No.	Name	Application
1	^{99m} Tc-Hynic-TOC	Neuroendocrine tumor imaging
2	^{99m} Tc-Hynic-TATE	Neuroendocrine tumor imaging
3	^{99m} Tc-HSA-Nanocolloid	Detection of sentinel nodes in breast cancers
4	^{99m} Tc-UBI (29-41)	Infection imaging
5	^{99m} Tc-HYNIC-[cyclo(RGDfk)]2	Malignant tumor imaging
6	^{99m} Tc-TRODAT	Diagnostic imaging of Parkinson
7	⁶⁸ Ga-DOTA-TOC	Neuroendocrine tumor imaging
8	⁶⁸ Ga-PSMA-11	Prostate cancer imaging
9	[⁶⁴ Cu]CuCl ₂ Produced by (n,γ) route	Cancer imaging
10	[⁶⁴ Cu]CuCl ₂ (No-carrier-added)	Cancer imaging & ⁶⁴ Cu-radiopharmaceutical preparatio
11	¹⁷⁷ Lu-DOTA-TATE	Neuroendocrine cancer therapy
12	¹⁷⁷ Lu-DOTA-NOC	Neuroendocrine cancer therapy

13	^{177}Lu -EDTMP	Bone pain palliation		
14	^{177}Lu -Hydroxyapatite	Radiation synovectomy		
15	^{177}Lu -PSMA-617	Prostate cancer therapy		
16	^{177}Lu -DOTMP	Bone pain palliation		
17	^{177}Lu -CHX-A-DTPA-Rituximab	Therapy Lymphoma	of	Non-I
18	^{177}Lu -DOTA-Rituximab	Therapy Lymphoma	of	Non-I
19	^{177}Lu -DOTA-Trastuzumab	Breast cancer therapy		
20	^{131}I -Lipiodol	Liver cancer therapy		
21	^{188}Re -HEDP	Bone pain palliation		
22	^{188}Re -DEDIC-Lipiodol	Liver cancer therapy		
23	^{90}Y -DOTA-TATE	Neuroendocrine cancer therapy		
24	^{90}Y -Glass microsphere (BhabhaSphere)	Treatment of liver cancer		
25	^{90}Y -Hydroxyapatite	Radiation synovectomy		
26	^{166}Ho -labeled resin microspheres	Liver cancer therapy		

Nuclear technology in Agriculture Sector:

In agriculture, DAE has developed 72 improved crop varieties using radiation-induced mutagenesis along with cross breeding, which have been released and notified for commercial cultivation across the country in collaboration with ICAR and State Agricultural Universities. These varieties include rice, mustard, sesame, groundnut, uradbean, mungbean, pigeonpea, sorghum, cowpea, wheat, soybean, sunflower, banana, linseed and jute. Some of the desirable traits in these crops include higher yield, seed size, and quality traits, early maturity, climate resilient traits like drought, heat, salinity tolerance and resistance to diseases. Several of these varieties have high patronage from the farming community and are extensively grown in the country.

DAE is promoting the use of radiation technologies for preservation of food and agricultural products by developing standard operating procedures (SOPs) for irradiation of agricultural commodities, preparing standards and guidelines for food irradiation, developing improved radiation facilities, and transferring radiation-based food preservation technologies to private entrepreneurs for commercialisation. Radiation processing extends the shelf life of perishable

produce, reduces post-harvest losses, enables chemical-free preservation of grains and spices, and helps meet international phytosanitary requirements for export. Currently, till date 42 food irradiation facilities have been commissioned in the country, including in the Government sector and in the private sector.

Cobalt 60 (Co-60) based irradiators are used for sterilisation of medical products and self-life extension of agriculture & marine products. Caesium (Cs) is used for blood irradiation in blood irradiators. DAE technologies are available for technology transfer at nominal fee on non-exclusive basis to private entrepreneurs.

To strengthen the adoption of radiation technology in food processing, the Government has announced incentives for setting up of multiproduct food irradiation units under 'Integrated Cold Chain & Value Addition Infrastructure' of the Pradhan Mantri Kisan Sampada Yojana (PMKSY) scheme across the nation in 2024-25.

This information was given by Union Minister of State for Prime Minister's office and Personnel, Public Grievances and Pensions, Atomic Energy and Space, Dr. Jitendra Singh, in a written reply in the Rajya Sabha today.

NKR/AK/NM

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