

The Science behind Nuclear medicine

Radionuclides used within Nuclear Medicine include the radioisotopes of iodine, gallium, thallium and technetium, amongst others. The physical characteristics of each are different and the selection of a particular radionuclide relates directly with its intended clinical use, that is, whether a diagnostic or therapeutic result is desired. The following table lists the most commonly used radionuclides.

Element	Radionuclide	Chemical Form	Half-life	Energy gamma (keV)	Energy beta (keV)
Phosphorus	32-P	Sodium phosphate	14.3 d		1700
Chromium	51-Cr	Sodium chromate	27.7 d	320	
Gallium	67-Ga	Gallium Citrate	78.3 h	91, 185, 200	
Strontium	89-Sr	Strontium chloride	50.5 d		1480
Yttrium	90-Y	Yttrium silicate	64.1 h		2280
Technetium	99m-Tc	See below	6.02 h	140	
Indium	111-In	Indium chloride	2.8 d	171, 245	
Iodine	131-I	Sodium iodide	8.0 d	364	606
Thallium	201-Tl	Thallos chloride	73.1 h	68-82 (Hg x-rays)	

Radioisotopes which emit gamma rays are used diagnostically whilst those that are beta particle emitters are used therapeutically. There are, however, a range of radioisotopes that emit a combination of gamma and beta particles, which allow their use in both areas. Iodine-131 is an example of such.

Technetium has become the most widely used radionuclide for diagnostic Nuclear Medicine. Its almost ideal physical characteristics of short half-life, low energy of its mono-energetic gamma ray and ease of chelation facilitates its incorporation into a wide range of radiopharmaceuticals. It is formed from the decay of a parent radionuclide, molybdenum-99, which through this parent-daughter process, can be provided in a convenient, readily available and mobile form, the Technetium Generator. Below is a description of some of the technetium labelled compounds available and their uses.

Radiopharmaceutical	Short form	Clinical Use
Technetium Sulphur Colloid	99mTcS/C	Reticulo Endothelial System (Liver, Spleen and Bone Marrow Scan)
Technetium Macro Aggregated Albumin	99mTcMAA	Pulmonary Blood Flow (Lung Scan)
Technetium Diethylene Triamino Penta Acetic Acid	99mTcDTPA	Renal Blood Flow, Function and Excretion (Kidney Scan)
Technetium Methylene DiPhosphonate	99mTcMDP	Skeletal Studies (Bone Scan)
Sodium Pertechnetate	Na ₂ 99mTcO ₄	Thyroid, Salivary Gland and Gastric Scans
99mTc Red Blood Cells	99mTcRBC	Cardiac Function and Blood Pool Scans
99mTc Sestamibi 99mTc Tetrofosmin	99mTcMIBI 99mTcTETRO	Myocardial Perfusion (Heart Muscle Blood Flow)
99mTc Hexa Methylene Propylene Amine Oxime	99mTc HMPAO	Brain Scan and Scans for Infection