

Let's be precise!

A practical short guidance to correct radiotracer nomenclature in nuclear medicine.

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General Rules:

- **Radiotracers** (= radioligands; radiopharmaceuticals) are chemical compounds and therefore need to be **written in an unambiguous way**.
- After **proper definition in the first place**, any easy and not misleading abbreviation can be used in the rest of the text.

Specific Rules:

- **Radionuclide in square brackets** and superscript the mass number if it is **part of a substance**.
E.g. [^{99m}Tc]Tc-xxx, [¹⁸F]xxx, [⁶⁸Ga]Ga-xxx, [¹⁷⁷Lu]Lu-xxx, ...
Explanation: square brackets are used because the radionuclide is either no-carrier-added (nca) or carrier-added (ca). Only if totally carrier-free, standard round brackets would have to be used. Ref: IUPAC (International Union of Pure and Applied Chemistry), Section H: Isotopically Modified Compounds (Recommendations 1978); <http://www.chem.qmul.ac.uk/iupac/sectionH/>
- The **name or tolerated abbreviation** of the chemical compound **needs to include the radiolabelled atom**. **No hyphen or space** is put **between the radiolabel and the atom**.
E.g. [^{99m}Tc]Tc-MAG3, 6-[¹⁸F]FDOPA, [⁶⁸Ga]Ga-PSMA-11, [¹⁷⁷Lu]Lu-PSMA-617, ...
Explanation: The radionuclide in the square brackets only tells us that this atom is partly present as this specific nuclide (and also at least in very small quantities as other nuclides. e.g. also ^{99g}Tc and ^{99m}Tc; ¹⁹F and ¹⁸F.). Hence, the respective atom needs to be part of the molecule and its name (e.g. DOPA does not contain a fluorine → 6-FDOPA; PSMA-11 does not contain a gallium → Ga-PSMA-11)
- **No use of square brackets** around radionuclides if it is **not part of a specific compound name**.
E.g. ^{99m}Tc-labelled compounds, ¹⁸F-fluorination, ⁶⁸Ga-tracers, ¹⁷⁷Lu-therapeutic, ...
- If there is **more than one compound for the same target** either list them explicitly or summarize them into a group.
E.g. PSMA-targeting radiopharmaceuticals, [¹⁷⁷Lu]Lu-PSMA-617 and analogues
- If there is more than one possible **position for radiolabelling** this needs to be noted as well.
E.g. [*S*-methyl-¹¹C]methionine vs. [C₁-¹¹C]methionine

Explanation: As stated in the general rules, chemical compound names need to be 100% precise and unambiguous. This is true for the position of the radiolabel, but also for the chemical name (and positions of the atoms therein) as well. (E.g. "PSMA" is ambiguous since there are PSMA-11, PSMA-617, PSMA-1007, PSMA-I&T, and many more available; "FDOPA" is also imprecise as the fluorine could be in present in more than one position → 6-FDOPA)

Additional Remarks:

- For more details, please see:
 - Coenen HH *et al.* **Consensus nomenclature rules for radiopharmaceutical chemistry – Setting the record straight.** *Nucl Med Biol* 2017;55:v-xi. (esp. subsection 3)
 - Coenen HH *et al.* **Open letter to journal editors on: International Consensus Radiochemistry Nomenclature Guidelines.** *EJNMMI Radiopharmacy and Chemistry* 2019;4: 7. (guidance doc.)
- Also, **pharmaceutical INNs (International Nonproprietary Names)** are officially tolerated but not used often outside Pharmacopoeias and the pharmacy sector. E.g. fludeoxyglucose (¹⁸F), lutetium (¹⁷⁷Lu) oxodrotreotide, gallium (⁶⁸Ga) edotreotide, iodine (¹³¹I) iobenguane ...
(*nota bene: the radionuclide in the INN is often in round brackets before or after the INN*)

Do's and Don't's:

Example 1

2-[¹⁸F]FDG	✓	"[¹⁸ F]FDG" is not perfect but tolerable. Full chemical name for reference: 2-deoxy-2-[¹⁸ F]fluoro-D-glucose or 2-[¹⁸ F]fluoro-2-deoxy-D-glucose
FDG	X	No radiolabel present. This is non-radioactive FDG.
¹⁸F-DG	X	3-times wrong; square brackets missing; no F in compound name; hyphen.
¹⁸FDG	X	No square brackets.
F-18-FDG	X	Mass number as superscript left of the element symbol; square brackets.
¹⁸F-FDG	X	Often seen but still wrong. Square brackets missing and no hyphen.
[¹⁸F]-FDG	X	No hyphen to be used between square brackets and compound.

Example 2

[⁶⁸Ga]Ga-PSMA-11	✓	Or similar for other PSMA-compound. Analogous for e.g. [¹⁷⁷ Lu]Lu-PSMA-617.
Ga-PSMA	X	No radiolabel present. This is non-radioactive PSMA. Which PSMA?

⁶⁸ Ga-PSMA	X	Square brackets missing; which PSMA?
[⁶⁸ Ga]-PSMA	X	No gallium in PSMA; which PSMA?
[⁶⁸ Ga]PSMA-11	X	No gallium in PSMA.

Example 3

[^{99m} Tc]Tc-DTPA	✓	Or similar for other ^{99m} Tc-labeled compounds.
Tc-DTPA	X	No radiolabel present. This is DTPA with whatever Tc.
⁹⁹ Tc-DTPA	X	Square brackets missing; ⁹⁹ Tc is not ^{99m} Tc.
^{99m} Tc-DTPA	X	Square brackets missing
[^{99m} Tc]DTPA	X	No technetium in DTPA.

Example 4

Na[¹⁸ F]F or [¹⁸ F]F ⁻	✓	Both fine as chemical representations.
[¹⁸ F]fluoride	✓	Also fine and more easy to read.
¹⁸ F	X	No chemical form. This is just the radionuclide.
¹⁸ F-fluoride	X	Often seen but still wrong. Square brackets missing and no hyphen.

Example 5

[¹⁷⁷ Lu]Lu-DOTA-TATE or Lutathera®	✓	Both fine. The registered trade mark name does already include the radiolabel.
Lu-DOTA-TATE	X	This is the non-radioactive version.
¹⁷⁷ Lu-DOTA-TATE	X	Often seen but still wrong. Square brackets missing and no hyphen.

Example 6

[¹⁸ F]PSMA-1007	✓	
[¹⁸ F]F-PSMA-1007	X	Here, the additional "F" is too much as "PSMA-1007" already includes a fluorine atom in its structure (and only one! - so it is clearly defined)
¹⁸ F-PSMA	X	Not clear which PSMA compound. Square brackets missing and no hyphen between radionuclide and compound name..