CLAIMS

We Claim:

1. A liquid radiopharmaceutical composition comprising:
   (a) a conjugate, wherein the conjugate is ^{225}Ac-DOTA-TATE;
   (b) one or more stabilizing agents; and
   (c) an aqueous vehicle.
2. A liquid radiopharmaceutical composition comprising:
   (a) a conjugate, wherein the conjugate is ^{225}Ac-DOTA-TOC;
   (b) one or more stabilizing agents; and
   (c) an aqueous vehicle.
3. A liquid radiopharmaceutical composition comprising:
   a) a conjugate that comprises
      (i) a targeting ligand, wherein the targeting ligand binds to a somatostatin receptor (SSR),
      (ii) a metal chelator covalently attached to the targeting ligand, and
      (iii) a radionuclide, wherein the radionuclide is ^{225}Ac and is bound to the metal chelator;
   b) one or more stabilizing agents; and
   c) an aqueous vehicle.
4. The radiopharmaceutical composition of any one of claims 1-3, wherein:
   a) the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content bound as part of the conjugate after 72 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC);
   b) wherein the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content bound as part of the conjugate after 120 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC);
   c) the radiopharmaceutical composition retains at least 95 % of the ^{225}Ac content bound as part of the conjugate after 120 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC);
   d) the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content bound as part of the conjugate after 120 hours at about 20ºC to about 25°C as determined by high performance liquid chromatography/fraction collection (HPLC-FC);
   e) the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content bound as part of the conjugate after 72 hours at about 20ºC to about 25°C as determined by high performance liquid chromatography/fraction collection (HPLC-FC);

f) the radiopharmaceutical composition retains at least 90 % of the radionuclide content as part of the conjugate after 168 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC);

g) the radiopharmaceutical composition retains at least 95 % of the radionuclide content as part of the conjugate after 168 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC);

h) the radiopharmaceutical composition retains at least 85 %, at least 90 %, at least 92 %, at least 95 %, at least 98 % or at least 99 % of the radionuclide content as part of the conjugate after 120 hours at room temperature (about 20ºC to about 25°C) as determined by radio thin-layer chromatography (radio-TLC); and/or

i) the radiopharmaceutical composition retains 95 % or more of the radionuclide content as part of the conjugate after 48 hours, 72 hours, 96 hours, 120 hours, 148 hours, 168 hours, 192 hours, or 216 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC).

5. The radiopharmaceutical composition of claim 3, wherein the targeting ligand binds to a somatostatin receptor type 1 (SSTR1), somatostatin receptor type 2 (SSTR2), somatostatin receptor type 3 (SSTR3), somatostatin receptor type 4 (SSTR4), and/or somatostatin receptor type 5 (SSTR5).

6. The radiopharmaceutical composition of any one of claims 3 to 5, wherein the targeting ligand is a binding peptide, optionally wherein the binding peptide comprises 6 to 14 amino acid residues.

7. The radiopharmaceutical composition of claim 6, wherein the binding peptide comprises an amino acid sequence with at least 90% identity to a sequence selected from SEQ IDs 1 to 96, or wherein the binding peptide comprises an amino acid sequence selected from SEQ IDs 1 to 96.

8. The radiopharmaceutical composition of any one of claims 3 to 7, wherein the targeting ligand is octreotate, octreotide, D-Phe^1-cyclo(Cys^2-Tyr^3-D-Trp^4-Lys^5-Thr^6-Cys^7)Thr^8 (tyr^3-octreotate or TATE), D-Phe^1-cyclo(Cys^2-Tyr^3-D-Trp^4-Lys^5-Thr^6-Cys^7)Thr(ol)^8 (Phe^1-Tyr^{3}octreotide, edotreotide, or TOC), D-Phe^1-cyclo(Cys^2-Phe^3-D-Trp^4-Lys^5-Thr^6-Cys^7)Thr(ol)^8 (OC), D-Phe^1-cyclo(Cys^2-1-Nal-D-Trp^4-Lys^5-Thr^6-Cys^7)Thr(ol)^8 (NOC), p-Cl-Phe-cyclo(D-Cys-Aph(Hor)-D-Aph(Cbm)-Lys-Thr-Cys)D-Tyr-NH_2) (JR-11), or p-Cl-Phe-cyclo(D-Cys-Tyr-D-Aph(Cbm)-Lys-Thr-Cys)-D-Tyr-NH_2 (LM3), preferably wherein the targeting ligand is JR-11, tyr^3-octreotate, edotreotide, octreotate, or octreotide, further preferably wherein the targeting ligand is tyr^3-octreotate.

9. The radiopharmaceutical composition of any one of claims 3 to 5, wherein the targeting ligand is a small molecule compound selected from L-797,591, L-779,976, L-796,778, L-803,087, and L-817,818.
10. The radiopharmaceutical composition of any one of claims 3 to 9, wherein a binding affinity of the targeting ligand to a human SSR is not more than 250 nM, as determined by half maximal inhibitory concentration (IC_{50}), optionallywherein the human SSR is SSTR2.
11. The radiopharmaceutical composition of any one of claims 3 to 10, wherein the targeting ligand is covalently linked to the metal chelator through a linker, optionally wherein the linker comprises one or more groups selected from: substituted or unsubstituted alkyl, substituted or unsubstituted heteroalkyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocycloalkyl, substituted or unsubstituted aryl, and substituted or unsubstituted heteroaryl.
12. The radiopharmaceutical composition of any one of claims 3 to 10, wherein the metal chelator is selected from AAZTA, BAT, BAT-TM, Crown, Cyclen, DO2A, CB-DO2A, DO3A, H3HP-DO3A, Oxo-DO3A, p-NH_2-Bn-Oxo-DO3A, DOTA, DOTA-3py, DOTA-PA, DOTA-GA, DOTA-4AMP, DOTA-2py, DOTA-1py, p-SCN-Bn-DOTA, CHX-A″-EDTA, MeO-DOTA-NCS EDTA, DOTAMAP, DOTAGA, DOTAGA-anhydride, DOTMA, DOTASA, DOTAM, DOTP, CB-Cyclam, TE2A, CB-TE2A, CB-TE2P, DM-TE2A, MM-TE2A, NOTA, NOTP, HEHA, HEHA-NCS, p-SCN-Bn-HEHA, DTPA, CHX-A″-DTPA, p-NH_2-Bn-CHX-A″-DTPA, p-SCN-DTPA, p-SCN-Bz-Mx-DTPA, 1B4M-DTPA-DTPA, p-SCN-Bn1B-DTPA, p-SCN-Bn-1B4M-DTPA, p-SCN-Bn-CHX-A″-DTPA, PEPA, p-SCN-Bn-PEPA, TETPA, DOTPA, DOTMP, DOTPM, t-Bu-calix[4]arene-tetracarboxylic acid, macropa, macropa-NCS, macropid, H_3L^1, H_3L^4, H_2azapa, H_5decapa, bispa^2, H_4pypa, H_4octapa, H_4CHXoctapa, p-SCN-Bn-H_4octapa, p-SCN-Bn-H_4octapa, TTHA, p-NO_2-Bn-neunpa, H_4octox, H_2macropa, H_2bispa^2, H_4phospa, H_6phospa, p-SCN-Bn-H_6phospa, TETA, p-NO_2-Bn-TETA, TRAP, TRAP-Pr, TPA, HBED, SHBED, HBED-CC, (HBED-CC)TFP, DMSA, DMPS, DHLA, lipoic acid, TGA, BAL, Bis-thioseminarabazones, p-SCN-NOTA, nNOTA, NODAGA, CB-TE1A1P, 3P-C-NETA-NCS, 3p-C-DEPA, 3P-C-DEPA-NCS, TCMC, PCTA, NODIA-Me, TACN, pycup1A1B, pycup2A, THP, DEDPA, H_2DEDPA, p-SCN-Bn-H_2DEDPA, p-SCN-Bn-TCMC, motexafin, NTA, NOC, 3p-C-NETA, p-NH_2-Bn-TE3A, SarAr, DiAmSar, SarAr-NCS, AmBaSar, BaBaSar, TACN-TM, CP256, C-NE3TA, C-NE3TA-NCS, NODASA, NETA-monoamide, C-NETA, TACN-HSB, NOPO, BPCA, p-SCN-Bn-DRO, DRO-ChX-Mal, DFO, DFO-IAC, DFO-BAC, DiP-LICAM, EC, SBAD, BAPEN, TACHPYR, NEC-

SP, L^{py}, L1, L2, L3, and EuK-106; or wherein the metal chelator is a metal chelator in FIG. 3 to FIG. 17.

13. The radiopharmaceutical composition of any one of claims 3 to 10, wherein the metal chelator is DOTA.
14. The radiopharmaceutical composition of any one of claims 1 to 13, wherein the one or more stabilizing agents comprise a radiolysis stabilizer, optionally wherein the radiolysis stabilizer is
    a) an amino acid, a peptide or a derivative thereof,
    b) a vitamin or a derivative thereof,
    c) a lipid or a derivative thereof,
    d) a carbohydrate or a derivative thereof,
    e) a volume expander,
    f) an antioxidant, or
    g) a combination thereof.
15. The radiopharmaceutical composition of claim 14, wherein the amino acid or peptide is selected from N-Acetyl-L-cysteine, Glutathione, L-Lysine, Selenol-L-methionine, Glutathione, Albumin, Melatonin, Taurine, Alanine, Arginine, Asparagine, Aspartic acid, Cysteine, Glutamine, Glutamic acid, Glycine, Histidine, Isoleucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Tyrosine, Valine, and derivatives thereof.
16. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer comprises an antioxidant, optionally wherein the antioxidant is a flavonoid or a derivative thereof, optionally wherein the flavonoid is a catechin or a derivative thereof; or wherein the antioxidant is N-acetyl cysteine, Ascorbic acid (e.g., L-ascorbic acid), N-tert-Butyl-α-phenylnitrone, 3-(3,4-Dihydroxyphenyl)-2-propenoic acid (Caffeic Acid), β-Carotene, Provitamin A, (2S,3R)-2-(3,4-Dihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol 3-(3,4,5-trihydroxybenzoate ((-) Catechin gallate or CG), 1,4,5-Trihydroxycyclohexanecarboxylic acid, trans-4-Hydroxycinnamic acid (p-Coumaric acid), 3,3',4',5,5',7-Hexahydroxyflavylium chloride, Thiocytic Acid (Dihydrolipoic Acid, DHLA), 4,4',5,5',6,6'-Hexahydroxydiphenic acid 2,6,2',6'-dilactone (Ellagic acid), (-)-cis-3,3',4',5,7-Pentahydroxyflavane (Epi-Catechin or EC), 2-Methoxy-4-(2-propenyl) phenol, trans-4-Hydroxy-3-methoxycinnamic acid (Ferulic acid), 7-Hydroxy-3-(4'-methoxyphenyl)-4H-benzopyran-4-one, all-trans-Fucoxanthin, 3,4,5-Trihydroxybenzoic acid (Gallic acid), (2S,3R)-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol ((-)-Gallocatechin), Glutathione, 2-(3,4-Dihydroxyphenyl)ethanol, 3,4',5,7-

Tetrahydroxyflavone (Kaempferol), (±)-1,2-Dithiolane-3-pentanoic acid, Luteolin, Lycopene, L-Lysine, Neochlorogenic acid, Oleic acid, trans-3,5,4'-Trihydroxystilbene (Resveratrol), 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-[(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-[[(2R,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxymethyl]oxan-2-yl]oxychromen-4-one, Rutin hydrate, Selenol-L-methionine, Thiourea, (+)-α-Tocopherol, Xanthophyll, Citric acid (CA), Gentisic acid (GA), Salicylic acid (SA), Erythorbic acid (EA), Phenol, Sodium bisulfite, Butylated hydroxy anisole, Butylated hydroxy toluene, Metabisulfite, Benzyl alcohol, Thymol, Lipoic acid (LA), Thioglycolic acid (TGA), 2,3 Dimercaptopropan-1-ol (BAL), Zinc, Selenium, Albumin, Ethanol, Mannitol, Sucrose, Melatonin, Ebselen, Pyruvic acid, Carboxy-PTIO, Trolox, Uric acid, Edaravone, Beta carotene, NADPH, Lycopene, Lutein, Catalase, Estrogen, Estradiol, Estriol, Ubiquinol, Copper, Quercetin, Cortisone, Taurine, (2R,3R)-5,7-Dihydroxy-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-1-benzopyran-3-yl 3,4,5-trihydroxybenzoate (EpiGallo-Catechin gallate or EGCg), (2R,3R)-2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3,4-dihydro-2H-chromen-3-yl] 3,4,5-trihydroxybenzoate or Epi-Catechin Gallate (ECG), (2R,3R)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol (Epigallo-Catechin or EGC), (2R,3S)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol (Gallo-Catechin or GC), (−)-cis-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol 3-gallate ((-)-Epigalocatechin-3-O-Gallate), 5-Aminolevulibic Acid hydrate, Ploysorbate 80, Garlic Acid, Sodium L-Ascorbate, Hyaluronic Acid, Dextran 60-90, Selenol, and LysaKare.

17. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer is a vitamin or a derivative thereof, optionally wherein the vitamin or a derivative thereof is selected from L-Ascorbic acid, β-Carotene, Provitamin A, (+)-α-Tocopherol, Erythorbic acid (EA), Trolox, and Lutein, or a salt thereof.
18. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer is a carbohydrate or a derivative thereof, optionally wherein the carbohydrate is Mannitol, Sucrose, Dextran (e.g., Dextran 40, Dextran 70), or Cyclodextrin (e.g., α-cyclodextrin, β-cyclodextrin, and γ-cyclodextrin).
19. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer is a volume expander, and wherein the volume expander is a polymer or a polymer mixture that comprises PEG (e.g., Mn 2000 to 5000), Polygeline, Haemaccel, Gelofusine, PLENVU (polyethylene glycol 3350, sodium sulfate, ascorbic acid, sodium chloride and potassium chloride US FDA 2018 Label), or a combination thereof.

20. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer is selected from N-Acetyl-L-cysteine, L-Ascorbic acid, N-tert-Butyl-α-phenylnitrone, 3-(3,4-Dihydroxyphenyl)-2-propenoic acid (Caffeic Acid), β-Carotene, Provitamin A, (2S,3R)-2-(3,4-Dihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol 3-(3,4,5-trihydroxybenzoate ((-) Catechin gallate, or CG), 1,4,5-Trihydroxycyclohexanecarboxylic acid, trans-4-Hydroxycinnamic acid (p-Coumaric acid), 3,3',4',5,5',7-Hexahydroxyflavylium chloride, Thiocytic Acid (Dihydrolipoic Acid, DHLA), 4,4',5,5',6,6'-Hexahydroxydiphenic acid 2,6,2',6'-dilactone (Ellagic acid), (-)-cis-3,3',4',5,7-Pentahydroxyflavane (Epi-Catechin or EC), 2-Methoxy-4-(2-propenyl) phenol, trans-4-Hydroxy-3-methoxycinnamic acid (Ferulic acid), 7-Hydroxy-3-(4'-methoxyphenyl)-4H-benzopyran-4-one, all-trans-Fucoxanthin, 3,4,5-Trihydroxybenzoic acid (Gallic acid), (2S,3R)-2-(3,4,5-Trihydroxyphenyl)-3,4-dihydro-1(2H)-benzopyran-3,5,7-triol ((-)-Gallocatechin), Glutathione, 2-(3,4-Dihydroxyphenyl)ethanol, 3,4',5,7-Tetrahydroxyflavone (Kaempferol), (±)-1,2-Dithiolane-3-pentanoic acid, Luteolin, Lycopene, L-Lysine, Neochlorogenic acid, Oleic acid, trans-3,5,4'-Trihydroxystilbene (Resveratrol), 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-[(2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-[[(2R,3R,4R,5R,6S)-3,4,5-trihydroxy-6-methyloxan-2-yl]oxymethyl]oxan-2-yl]oxychromen-4-one, Rutin hydrate, Selenol-L-methionine, Thiourea, (+)-α-Tocopherol, Xanthophyll, Alanine and its derivatives, Arginine and its derivatives, Asparagine and its derivatives, Aspartic acid and its derivatives, Cysteine and its derivatives, Glutamine and its derivatives, Glutamic acid and its derivatives, Glycine and its derivatives, Histidine and its derivatives, Isoleucine and its derivatives, Lysine and its derivatives, Methionine and its derivatives, Phenylalanine and its derivatives, Proline and its derivatives, Serine and its derivatives, Threonine and its derivatives, Tryptophan and its derivatives, Tyrosine and its derivatives, Valine and its derivatives, Citric acid (CA), Gentisic acid (GA), Salicylic acid (SA), Erythorbic acid (EA), Phenol, Sodium bisulfite, Butylated hydroxy anisole, Butylated hydroxy toluene, Glutathione, Metabisulfite, Benzyl alcohol, Thymol, Lipoic acid (LA), Thioglycolic acid (TGA), 2,3 Dimercaptopropan-1-ol (BAL), Zinc, Selenium, Albumin, Ethanol, Mannitol, Sucrose, Melatonin, Ebselen, Pyruvic acid, Carboxy-PTIO, Trolox, Uric acid, Edaravone, Beta carotene, NADPH, Lycopene, Lutein, Catalase, Estrogen, Estradiol, Estriol, Ubiquinol, Copper, Quercetin, Cortisone, 2,3-dimercaptosuccinic acid (DMSA), monisoamyl derivative (MiADMSA), Taurine, Dextran (e.g., Dextran 40, Dextran 70), PEG (e.g., PEG 3350 and PEG 4000), Polygeline, Gelofusine, PLENVU (polyethylene glycol 3350, sodium sulfate, ascorbic acid, sodium chloride and potassium chloride US FDA 2018

Label), Cyclodextrins (e.g., α-cyclodextrin, β-cyclodextrin, and γ-cyclodextrin), (2R,3R)-5,7-Dihydroxy-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-1-benzopyran-3-yl 3,4,5-trihydroxybenzoate (EpiGallo-Catechin gallate or EGCg), (2R,3R)-2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3,4-dihydro-2H-chromen-3-yl] 3,4,5-trihydroxybenzoate or Epi-Catechin Gallate (ECG), (2R,3R)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol (Epigallo-Catechin or EGC), (2R,3S)-2-(3,4,5-trihydroxyphenyl)-3,4-dihydro-2H-chromene-3,5,7-triol (Gallo-Catechin or GC), or a combination thereof.

21. The radiopharmaceutical composition of claim 14, wherein the radiolysis stabilizer is ascorbic acid or a salt thereof, ethanol, gentisic acid or a salt thereof.
22. The radiopharmaceutical composition of any one of claims 14 to 21, wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at about 0.01 mM to about 5 M; or wherein the stabilizing agent is present in the radiopharmaceutical composition from about 5 mM, 10 mM, 25 mM, 50 mM, or 75mM to about 80 mM, 100 mM, 125 mM, 150 mM, 175 mM, 200 mM, 250 mM, or 500 mM; or wherein the stabilizing agent is present in the radiopharmaceutical composition at about 10 mM to about 500 mM or at about 50 mM to about 200 mM; or wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at about 0.0001 wt% to about 10 wt%; or wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at about 0.01 wt% to about 5 wt%, about 0.05 wt% to about 2 wt%, or about 0.1 wt% to about 1 wt%; or wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at a concentration of from about 0.1 to 50 mg/mL.
23. The radiopharmaceutical composition of any one of claims 1 to 22, wherein the one or more stabilizing agents comprise a free metal chelator, wherein the free metal chelator is not attached to the targeting ligand, optionally wherein the free metal chelator is selected from Ethylenediaminetetraacetic acid (EDTA), Diethylenetriaminepentaacetic acid (DTPA), 2-S-(4-Isothiocyanatobenzyl)-1,4,7-triazacyclononane-1,4,7-triacetic acid (NOTA), Triethylenetetramine (TETA), 1, 4, 7, 10, 13-pentaazacyclopentadecane-N, N', N", N"', N""-pentaacetic acid (PEPA), TETPA, 2,2′,2”-(10-(2,6-dioxotetrahydro-2H-pyran-3-yl)-1,4,7,10-tetraazacyclododecane-1,4,7-triyl)triacetic acid (DOTA-GA), 1,4,7,10-Tetraazacyclododecane-1,4,7,10-tetra(methylene phosphonic acid (DOTP), Deferoxamine (DFO), N, N-bis(2-hydroxybenzyl)ethylenediamine-N,N-diacetic acid (HBED), 1,4,7,10-Tetraazacyclododecane-1,4,7,10-tetra(methylene phosphonic acid) (DOTP), 6,6'-((1,4,10,13-tetraoxa-7,16-diazacyclooctadecane-7,16-diyl)bis(methylene))dipicolinic acid (Macropa), Meso-2,3-dimercaptosuccinic acid

(DMSA), Dimercaptopropane sulfonate (DMPS), Dihydrolipoic acid (DHLA), Lipoic acid (LA), Thioglycolic acid (TGA), 2,3 Dimercaptopropan-1-ol (BAL), preferably wherein the free metal chelator is EDTA, DTPA, or Macropa.

24. The radiopharmaceutical composition of claim 23, wherein the free metal chelator is present in the radiopharmaceutical composition at about 0.001 wt% to about 10 wt%; or at about 0.01 wt% to about 5 wt%, about 0.05 wt% to about 2 wt%, or about 0.1 wt% to about 1 wt%; or wherein the free metal chelator is present in the radiopharmaceutical composition at a concentration of from 0.001 to 50 mg/mL (e.g., 0.01 to 5 mg/mL, 0.01 to 1 mg/mL, 0.01 to 0.5 mg/mL, or 0.01 to 1 mg/mL); or wherein the free metal chelator is present in the radiopharmaceutical composition at about 10 mM to about 500 mM, or at about 5 mM to 10 mM, 10mM to 25 mM, 25 mM to 50 mM, 50 mM to 75 mM, 75mM to 100 mM, or 100 mM to 200 mM.

25. The radiopharmaceutical composition of any one of claims 1 to 24, wherein the one or more stabilizing agents comprise one or more pH stabilizers,wherein the one or more pH stabilizers comprise an organic acid, or a salt thereof, optionally wherein the organic acid is an acetic acid, fumaric acid, ascorbic acid, propionic acid, benzene sulfonic acid, carbonic acid, citrate acid, aspartic acid, maleic acid, methane sulfonic acid, or tartaric acid; or wherein the one or more pH stabilizers comprise an inorganic acid, or a salt thereof; or wherein the one or more pH stabilizers comprise a base, or a salt thereof; or wherein the one or more pH stabilizers comprise an amino acid or a salt thereof, and wherein the amino acid is glycine, lysine, arginine, histidine or a combination thereof; or wherein the one or more pH stabilizers comprise an alkaline salt, an acid salt, or both, optionally wherein the alkaline salt is sodium acetate, sodium ascorbate, sodium benzoate, sodium bicarbonate, sodium carbonate, tribasic sodium phosphate acid, dibasic sodium phosphate acid, monobasic sodium phosphate acid, sodium tartrate, sodium lactate, sodium succinate, or disodium succinate; or wherein the one or more pH stabilizers comprise Sodium acetate, Sodium ascorbate, Ascorbic acid, Acetic acid, Fumaric acid propionic acid, ascorbic acid, ammonium sulfate, ammonium hydroxide, arginine, aspartic acid, benzene sulfonic acid, sodium benzoate, sodium bicarbonate, boric acid, sodium carbonate, carbonic acid, diethanolamine, citrate acid, hydrobromic acid, glycine, histidine, sodium lactate, (l)-lysine, maleic acid, methane sulfonic acid, phosphate acid, monobasic sodium phosphate acid, tribasic sodium phosphate acid, dibasic sodium phosphate acid, sodium hydroxide, sodium/disodium succinate, sulfuric acid, sodium tartrate, tartaric acid, tromethamine (tris), or a combination thereof.

26. The radiopharmaceutical composition of claim 25, wherein the one or more pH stabilizers are present in the radiopharmaceutical composition at about 0.001 wt% to about 10 wt%, or at about 0.01 wt% to about 5 wt%, about 0.05 wt% to about 2 wt%, or about 0.1 wt% to about 1 wt%; or wherein the one or more pH stabilizers are present in the radiopharmaceutical composition at a concentration of from 0.1 to 5 mg/mL; or wherein the one or more pH stabilizers are present in the radiopharmaceutical composition at about 10 mM to about 500 mM, or at about 0.1 mM to 2 mM, 1mM to 2 mM, 1 mM to 10 mM, 5 mM to 10 mM, 5 mM to 15 mM, 1 mM to 15 mM or 1 mM to 25 mM.
27. The radiopharmaceutical composition of claim 25 or claim 26, wherein the one or more pH stabilizers are configured to maintain a pH of the radiopharmaceutical composition at about 4 to about 8, or at about 5 to about 7.
28. The radiopharmaceutical composition of any one of claims 1 to 27, wherein the pH of the radiopharmaceutical composition is within a range of about 4 to about 8, or wherein the pH of the radiopharmaceutical composition is about 5.5 to about 6.0.
29. The radiopharmaceutical composition of any one of claims 1 to 28, wherein the composition comprises one or more stabilizing agents selected from Table 2, Table 3, and Table 4.
30. The radiopharmaceutical composition of any one of claims 1 to 29, wherein the aqueous vehicle comprises water, saline solution, dextrose in water, dextrose in saline solution, Ringer's solution, or lactated Ringer's solution, preferably wherein the aqueous vehicle is a saline solution.
31. The radiopharmaceutical composition of any one of claims 1 to 30, wherein the radiopharmaceutical composition is a solution or suspension, and/or wherein the radiopharmaceutical composition is formulated for IV infusion or bolus injection.
32. The radiopharmaceutical composition of any one of claims 1 to 31, wherein the radiopharmaceutical composition further comprises one or more excipients selected from: a tonicity adjusting agent, a preservative, an antimicrobial agent, a solubilizing agent, a suspending agent, and a surfactant.
33. The radiopharmaceutical composition of any one of claims 1 to 32, wherein the actinium-225 is present in the radiopharmaceutical composition that it provides a volumetric radioactivity of about 5 to 200 kBq/mL; or wherein the actinium-225 is present in the radiopharmaceutical composition that it provides a volumetric radioactivity of about 37 to 11,100 kBq/mL (about 1 to 300 µCi/mL), about 185 to 2,220 kBq/mL (about 5 to 60 µCi/mL), or about 440 to 851 kBq/mL (about 10 to 30 µCi/mL).

34. The radiopharmaceutical composition of any one of claims 1 to 33, wherein the composition contains no more than about 5% or no more than about 2% or about 1% free actinium-225 after 168 hours at about 20ºC to about 25°C, compared to the total amount of the actinium-225 in the composition as determined by radio thin-layer chromatography (radio-TLC); or wherein the composition contains no more than a total of 5 % of un-chelated daughter isotopes of actinium-225 after 168 hours at about 20ºC to about 25°C, compared to the total amount of the actinium-225 in the composition as determined by radio thin-layer chromatography (radio-TLC).

35. The radiopharmaceutical composition of any one of claims 1 to 13, comprising:

(a) the conjugate, wherein the conjugate is present in the radiopharmaceutical composition at a concentration equivalent to about 5 to about 100 mCi/L (e.g., about 10 to about 50 mCi/L);

(b) a radiolysis stabilizer, wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at a concentration of about 50 to about 500 mM (e.g., about 80 to about 120 mM);

(c) optionally a pH stabilizer, optionally a second radiolysis, or both, wherein the second radiolysis stabilizer is optionally present in the radiopharmaceutical composition at concentration of about 1 wt% to about 10wt%;

(d) a free metal chelator, therein the free metal chelator is present in the radiopharmaceutical composition at concentration of about 0.01 mg/mL to about 5 mg/mL (e.g., about 0.01 mg/mL to about 1 mg/mL); and

(e) an aqueous vehicle.

36. The radiopharmaceutical composition of claim 35, comprising:

(a) the conjugate, wherein the conjugate is present in the radiopharmaceutical composition at a concentration equivalent to about 10 to 50 mCi/L;

(b) a radiolysis stabilizer, wherein the radiolysis stabilizer is ascorbic acid or a salt thereof (e.g., sodium L-ascorbate), ethanol, gentisic acid or a salt thereof, and is present in the radiopharmaceutical composition at a concentration of about 50 mM to about 500 mM (e.g., about 80 to about 120 mM, about 50 mM to about 200 mM);

(c) a free metal chelator, wherein the free metal chelator is selected from EDTA, macropa, TETA, PEPA, TETPA, DFO, DOPT, DHLA, TGA, LA, and DTPA, or a combination thereof, and wherein the free metal chelator is present in the radiopharmaceutical composition at a concentration of about 0.01 mg/mL to about 5 mg/mL; and

(d) an aqueous vehicle, wherein the aqueous vehicle is saline solution.

37. The radiopharmaceutical composition of any one of claims 1 to 13, comprising:

(a) the conjugate, wherein the conjugate is present in the radiopharmaceutical composition at a concentration equivalent to about 10 to 50 mCi/L;

(b) a radiolysis stabilizer;

(c) optionally a pH stabilizer, wherein the pH stabilizer is configured to maintain a pH of the radiopharmaceutical composition at about 4 to 8;

(d) a free metal chelator, wherein the free metal chelator is configured to maintain a level of free radionuclide in the radiopharmaceutical composition below about 0.05 mCi/L; and

(e) an aqueous vehicle.

38. The radiopharmaceutical composition of claim 37, wherein the free metal chelator is configured to maintain a level of free radionuclide in the radiopharmaceutical composition below about 0.05 mCi/L for at least 72 hour at about at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC).

39. A liquid radiopharmaceutical composition comprising:

(a) a conjugate that comprises

(i) a targeting ligand, wherein the targeting ligand binds to a somatostatin receptor (SSR),

(ii) a metal chelator covalently attached to the targeting ligand, and

(iii) a radionuclide, wherein the radionuclide is ^{225}Ac,

(b) a means for scavenging free radicals in the radiopharmaceutical composition or a means for maintaining a pH of the radiopharmaceutical composition, wherein the pH of the radiopharmaceutical composition is about 4 to about 8;

(c) a means for scavenging free radionuclide in the radiopharmaceutical composition; and

(d) an aqueous vehicle;

wherein the radiopharmaceutical composition is a solution, and

wherein the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content as part of the radionuclide after 120 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC).

40. A liquid radiopharmaceutical composition comprising:

(a) a conjugate that comprises

(i) a targeting ligand, wherein the targeting ligand binds to a somatostatin receptor (SSR),

(ii) a metal chelator covalently attached to the targeting ligand, and

(iii) a radionuclide, wherein the radionuclide is ^{225}Ac,

wherein the conjugate is present in the radiopharmaceutical composition at a concentration equivalent to about 1 mCi/L to about 50 mCi/L, or at a concentration equivalent to about 10 mCi/L to about 35 mCi/L, or at a concentration equivalent to about 10 mCi/L to about 25 mCi/L;

(b) a radiolysis stabilizer;

(c) a free metal chelator; and

(d) an aqueous vehicle;

wherein the radiopharmaceutical composition is a solution, and

wherein the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content as part of the radionuclide after 120 hours at about 20ºC to about 25°C as determined by radio thin-layer chromatography (radio-TLC).

41. The liquid radiopharmaceutical composition of claim 40, wherein the radiolysis stabilizer is ascorbic acid, a salt thereof, ethanol, gentisic acid or a salt thereof, or a combination thereof, optionally wherein the radiolysis stabilizer is present in the radiopharmaceutical composition at a concentration of about 50 mM to about 200 mM.
42. The liquid radiopharmaceutical composition of claim 40 or claim 41, wherein the free metal chelator is selected from EDTA, macropa, TETA, PEPA, TETPA, DFO, DOPT, DHLA, TGA, LA, and DTPA, or a combination thereof, optionally wherein the free metal chelator is present in the radiopharmaceutical composition at a concentration of about 0.01mg/mL to about 5 mg/mL.
43. The liquid radiopharmaceutical composition of any one of claims 39 to 42, wherein the conjugate is ^{225}Ac-DOTA-TATE, ^{225}Ac-HA-DOTA-TATE, ^{225}Ac-DOTA-TOC, or ^{225}Ac-DOTA-JR-11.
44. The liquid radiopharmaceutical composition of any one of claims 39 to 43, wherein the composition retains at least 90 % or at least 95% of the ^{225}Ac content as ^{225}Ac-DOTA-TATE after 168 hours at about 20ºC to about 25°C, or wherein the conjugate is ^{225}Ac-DOTA-TATE and the radiopharmaceutical composition retains at least 95 % of the ^{225}Ac content as ^{225}Ac-DOTA-TATE after 168 hours at about 20ºC to about 25°C; and/or wherein the conjugate is ^{225}Ac-DOTA-TATE and the radiopharmaceutical composition retains at least 90 % of the ^{225}Ac content bound as part of the conjugate after 120 hours at about 20ºC to about 25°C as determined by high performance liquid chromatography/fraction collection (HPLC-FC).

45. The liquid radiopharmaceutical composition of any one of claims 39 to 44, wherein the radiopharmaceutical composition is formulated as a unit dose form that contains about 5 ml to about 50 ml (e.g., about 10-15 ml, about 12mL) of the solution.
46. The liquid radiopharmaceutical composition of any one of claims 39 to 45, wherein the aqueous vehicle is a saline solution, optionally wherein the radiopharmaceutical composition is formulated for IV infusion.
47. Use of a liquid radiopharmaceutical composition of any one of the preceding claims in the manufacture of a medicament for treating a somatostatin receptor-positive (SSTR+) neuroendocrine tumor in a subject in need thereof, wherein the liquid radiopharmaceutical composition is to be administered to the subject in an effective amount.
48. The use of claim 47, wherein the neuroendocrine tumor is gastroenteropancreatic neuroendocrine tumor (GEP-NET).
49. The use of claim 47 or claim 48, wherein, prior to the administration of the liquid radiopharmaceutical composition, the subject received ^{177}Lu-DOTA-TATE or ^{177}Lu-DOTA-TOC treatment and the tumor has progressed.
50. The use of any one of claims 47 to 49, wherein the radiopharmaceutical composition is to be administered to the subject in an amount equivalent to about 60 kBq/kg body weight to 120 kBq/kg body weight per dose.
51. The use of any one of claims 47 to 50, wherein the radiopharmaceutical composition is to be administered at an 8-week interval.
52. The use of any one of claims 47 to 51, wherein the ^{225}Ac-DOTA-TATE is present in the radiopharmaceutical composition at a concentration equivalent to about 10 mCi/L to about 25 mCi/L.
53. A method of making a radiopharmaceutical composition of any one of claims 1 to 46, comprising:
    a) combining a radionuclide with an un-labeled conjugate, wherein the un-labeled conjugate comprises a targeting ligand and a metal chelator covalently attached to the targeting ligand, thereby producing a labeled conjugate, and
    b) combining the one or more stabilizing agents with the labeled conjugate.
54. A method of making a radiopharmaceutical composition of any one of claims 1 to 46, comprising:
    a) combining a radionuclide with an un-labeled conjugate in the presence of one or more stabilizer agents, wherein the un-labeled conjugate comprises a targeting

ligand and a metal chelator covalently attached to the targeting ligand, thereby producing a mixture comprising a labeled conjugate, and

b) optionally combining one or more stabilizing agents to the mixture.

55. Use of the radiopharmaceutical composition of any one of claims 1 46 in the manufacture of a medicament for treating a disease in a subject in need thereof wherein the radiopharmaceutical composition is to be administered to the subject, optionally wherein the disease is a cancer, optionally wherein the cancer is a somatostatin receptor-positive (SSTR+) cancer.
56. The use of claim 47 or 55, wherein the cancer is a neuroendocrine cancer, a lymphatic cancer, a pancreatic cancer, a pituitary cancer, a breast cancer, a lung cancer, a stomach cancer, medulloblastoma, or neuroblastoma, preferably wherein the cancer is a neuroendocrine cancer.
57. The use of claim 56, wherein the neuroendocrine cancer is a neuroendocrine lung cancer or a neuroendocrine pancreatic cancer, optionally wherein the neuroendocrine cancer is a Carcinoid tumor in the lungs, gastrointestinal tract or thymus, Pancreatic neuroendocrine tumor (e.g., Gastrinoma, Insulinoma, Glucagonoma, VIPoma) Medullary thyroid carcinoma, Merkel cell carcinoma, Pheochromocytoma of the adrenal gland, Adrenal cancer, Small cell carcinoma (such as in the lungs), or Large cell carcinoid tumor (such as in the lungs).
58. The use of claim 47, 55, or 56, wherein the subject has received a radiotherapy that comprises beta-particle emitting radionuclide prior to the administration of the radiopharmaceutical composition (such as ^{177}Lu-DOTA-TATE or ^{177}Lu-DOTA-TOC therapy).
59. The use of claim 55, wherein the cancer is a SSTR2+ lung neuroendocrine tumor, or wherein the cancer is small cell lung cancer (SCLC), or wherein the cancer is somatostatin receptor expressing (SSTR+) extensive stage small cell lung cancer (ES-SCLC).
60. The use of claim 59, wherein the SCLC is untreated, recurrent or refractory.
61. The use of claim 59, wherein the subject has received at most 1 cycle of platinum-etoposide and PD-L1 inhibitor therapy.
62. The use of any one of claims 55 to 61, wherein the cancer is untreated or wherein the cancer is recurrent or refractory.
63. The use of any one of claims 55 to 62, wherein the radiopharmaceutical composition is to be administered to the subject in an amount equivalent to about 1kBq/kg to about 0.2GBq/kg body weight per dose, or in an amount equivalent to about 5kBq/kg to about

50,000kBq/kg body weight per dose, about 20k Bq/kg to about 5,000kBq/kg body weight per dose, about 50k Bq/kg to about 500 kBq/kg body weight per dose, or about 50k Bq/kg to about 200 kBq/kg body weight per dose, or in an amount equivalent to about 60 kBq/kg to about 150 kBq/kg body weight per dose; or wherein the radiopharmaceutical composition is to be administered to the subject at a radioactivity of about 1 μCi to 1,000 μCi, about 10 μCi to 500 μCi, about 100 μCi to 500 μCi, about 100 μCi to 300 μCi, about 125 μCi to 275 μCi, about 50 μCi to 125 μCi, or about 10 μCi to 50 μCi, or at a radioactivity of about 125 μCi to 275 μCi, or at a radioactivity of about 125 μCi, 175 μCi, 225 μCi, or 275 μCi.

64. The use of any one of claims 55 to 63, wherein the radiopharmaceutical composition is to be administered at an 4 to 6-week interval.

65. Use of the radiopharmaceutical composition of any one of claims 1 to 46 in the manufacture of a medicament for treating an SSTR+ cancer in a subject in need thereof, wherein an H-score of a cancer sample of the subject is at least 11.

66. Use of the radiopharmaceutical composition of any one of claims 1 to 46 in the manufacture of a medicament for treating a disease in a subject in need thereof, wherein a level of SSTR expression is to be determined in a sample of the subject and wherein the radiopharmaceutical composition is to be administered to the subject;
optionally wherein the level of SSTR expression in a sample is to be determined by calculating an H-Score, and wherein the H-Score is between 11 and 300.

67. The liquid radiopharmaceutical composition of any one of claims 1-46 for use in therapy.