Неорганические вещества в медицине

I. Радиоактивные изотопы для целей диагностики и терапии

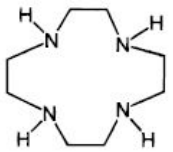
Важнейшие изотопы - γ-излучатели, используемые в целях радиодиагностики

isotope	$t_{1/2}$ (h)	production methods	decay mode	E_γ (keV)	E_{β^-} (keV)
^{67}Cu	62.01	accelerator, ^{67}Zn(n,p)	β^- (100%)	91, 93, 185	577, 484, 395
^{67}Ga	78.26	cyclotron	EC (100%)	91, 93, 185, 296 388	
^{90}Y	64.06	^{90}Sr/^{90}Y generator	β^- (72%)		2288
^{111}In	67.9	cyclotron, ^{111}Cd(p,n)^{111}In	EC (100%)	245, 172	
^{99m}Tc	6.0	^{99}Mo/^{99m}Tc generator	IT (100%)	141	
^{201}Tl	72 h	cyclotron	EC (100%)	135, 167	
		^{203}Tl(p,3n)^{201}Pb(p,n)^{201}Tl	Hg X-rays		

Важнейшие позитрон-излучающие изотопы, используемые в целях радиодиагностики

isotope	$t_{1/2}$(h)	methods of production	decay mode	E_{β^+} (keV)
^{55}Co	17.5	cyclotron, ^{54}Fe(d,n)^{55}Co	β^+ (77%) EC (23%)	1513, 1037
^{60}Cu	0.4	cyclotron, ^{60}Ni(p,n)^{60}Cu	β^+ (93%) EC (7%)	3920, 3000 2000
^{61}Cu	3.3	cyclotron, ^{61}Ni(p,n)^{61}Cu	β^+ (62%) EC (38%)	1220, 1150 940, 560
^{62}Cu	0.16	^{62}Zn/^{62}Cu generator	β^+ (98%) EC (2%)	2910
^{64}Cu	12.7	cyclotron, ^{64}Ni(p,n)^{64}Cu	β^+ (19%) EC (41%) β^- (40%)	656
^{66}Ga	9.5	cyclotron, ^{63}Cu(α,nγ)^{66}Ga	β^+ (56%) EC (44%)	4150, 935
^{68}Ga	1.1	^{68}Ge/^{68}Ga generator	β^+ (90%) EC (10%)	1880, 770
^{82}Rb	0.022	^{82}Sr/^{82}Rb generator	β^+ (96%) EC (4%)	3150
^{86}Y	14.7	cyclotron, ^{86}Sr(p,n)^{86}Y	β^+ (33%) EC (66%)	2335, 2019 1603, 1248 1043

Макроциклические лиганды, используемые для связывания ионов меди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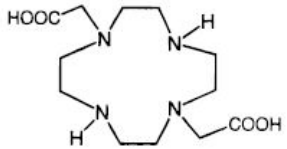
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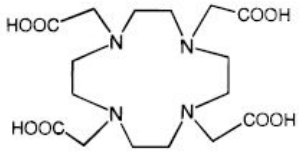
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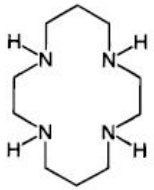
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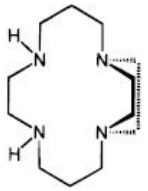
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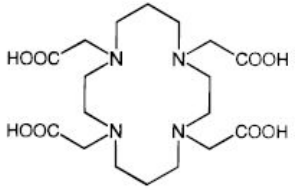
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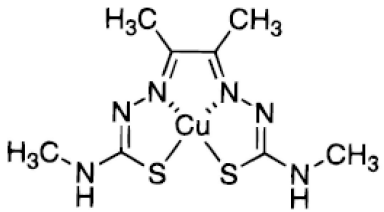
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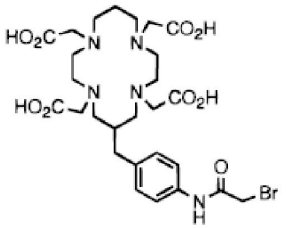
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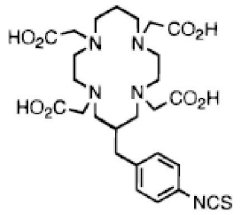
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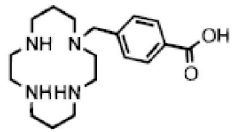
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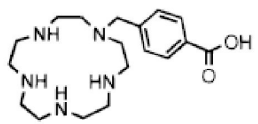
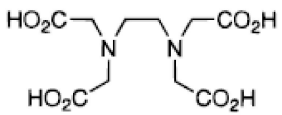

PCBA

Хелатообразующие лиганды, используемые для связывания ионов галлия и индия



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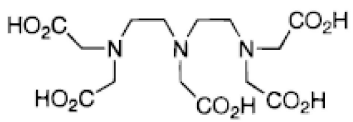

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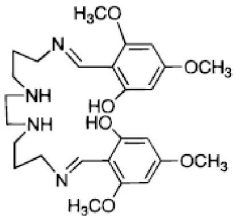
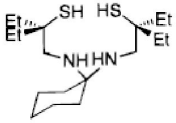
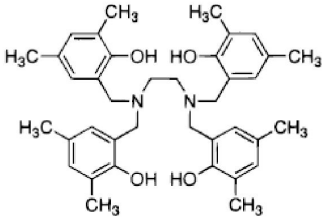


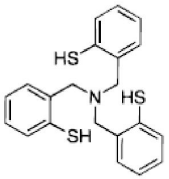
[(4,6-MeO_2sal)$_2$BAPEN]



BAT-TECH

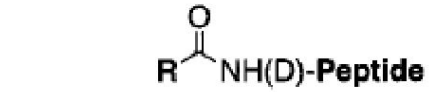


THM_2BED



tris(2-mercaptobenzyl)amine (S_3N)

Пептиды, селективно связываемые рецепторами соматостатина



Peptide =

NH_2(D)Phe - Cys - Phe - (D)Trp
Thr(OL) - Cys - Thr - Lys

Octreotide (OC)

NH_2(D)Phe - Cys - Tyr - (D)Trp
Thr(OL) - Cys - Thr - Lys

Tyr^3-Octreotide (Y3-OC)

NH_2(D)Phe - Cys - Phe - (D)Trp
Thr(OH) - Cys - Thr - Lys

Octreotate (TATE)

NH_2(D)Phe - Cys - Tyr - (D)Trp
Thr(OH) - Cys - Thr - Lys

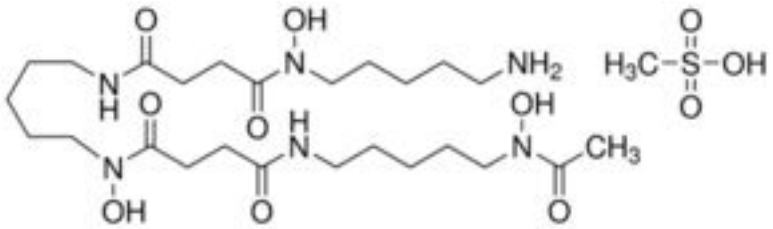
Tyr^3-Octreotate (Y3-TATE)

NH_2(D)βNal - Cys - Tyr - (D)Trp
Thr(NH_2) - Cys - Val - Lys

Lanreotide (LAN)

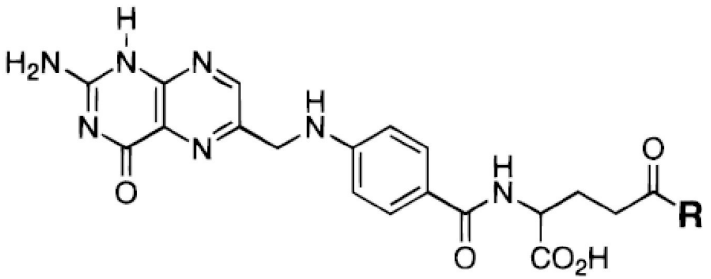
NH_2(D)Phe - Cys - Tyr - (D)Trp
Trp(NH_2) - Cys - Val - Lys

Vapreotide (RC-160)



Desferrioxamine B (DFO)

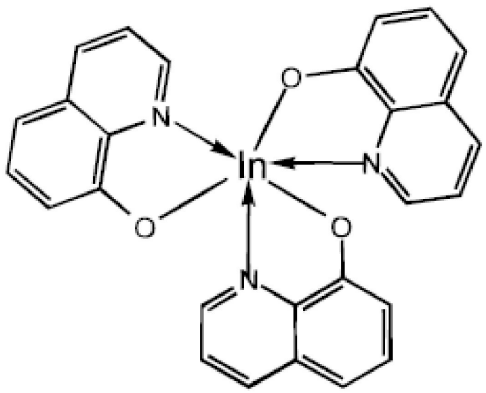
Лиганд для метки на рецепторы фолиевой кислоты



R = DTPA, DFO

Метка на отложения на стенках сосудов

(опасность тромбоза)



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		^{203}Tl(p,3n)^{201}Pb(p,n)^{201}Tl	Hg X-rays		

Некоторые применяемые в клинической практике препараты технеция

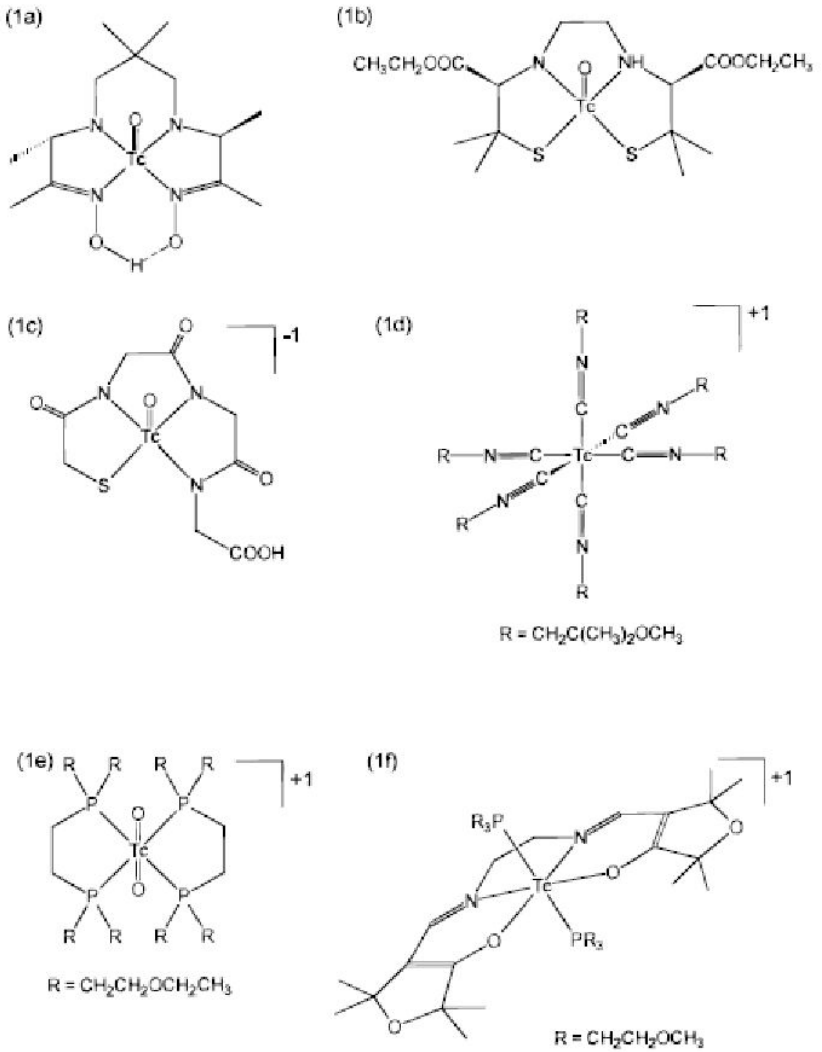


Figure 1. Some currently approved ^{99m}Tc radiopharmaceuticals: (a) ^{99m}Tc–D,L-HM-PAO (Ceretec); (b) ^{99m}Tc–LL-ECD (Neurolite); (c) ^{99m}Tc–MAG_3 (Technescan); (d) ^{99m}Tc–sestamibi (Cardiolite); (e) ^{99m}Tc–tetrofosmin (Myoview); (f) ^{99m}Tc–furifosmin (TechneScan Q12).

Радиоактивные метки для допамин-переносчиков

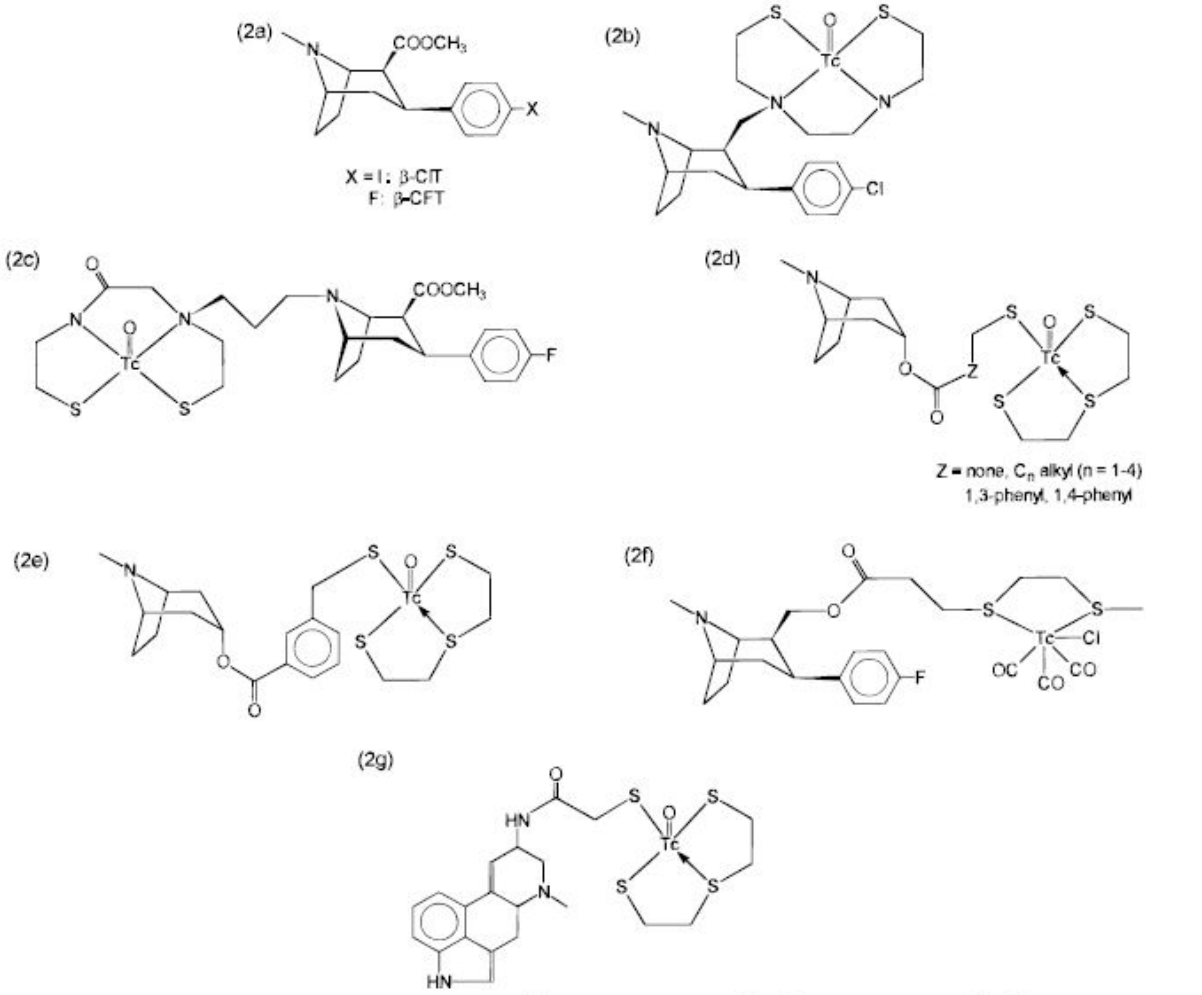
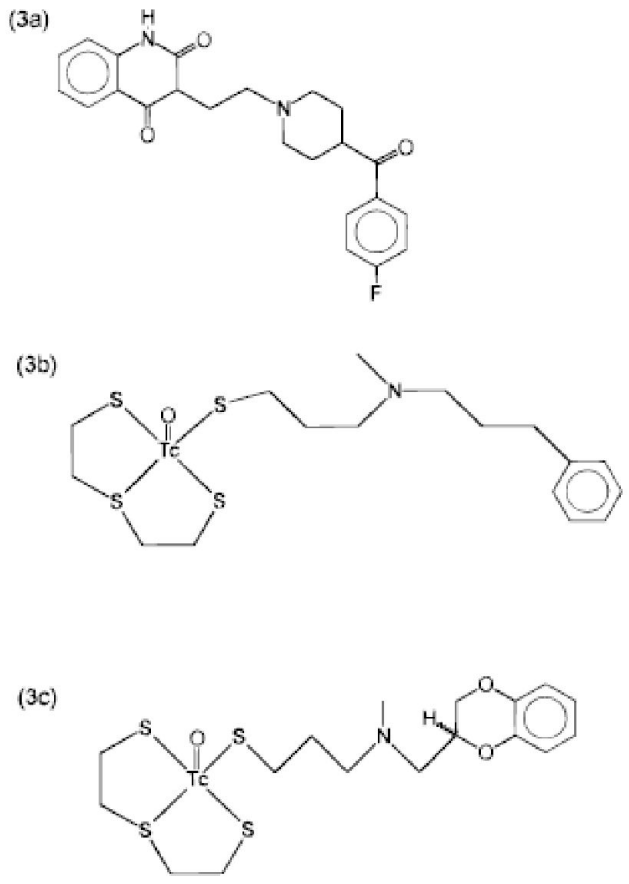
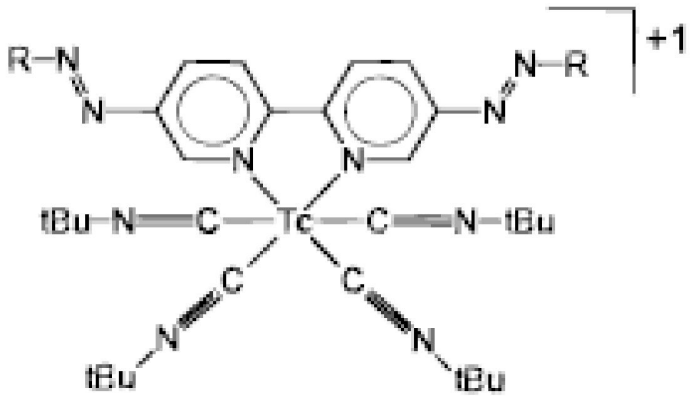


Figure 2. Dopamine transporter-selective molecules: (a) β-CIT or β-CFT; (b) [^{99m}Tc]TRODAT-1; (c) [^{99m}Tc]Technepine; (d) [^{99m}Tc]-3 + 1-α-tropanol; (e) [^{99m}Tc]-3 + 1-α-tropanol, Z = 1,3-phenyl; (f) [^{99m}Tc]TROTEC-1; (g) [^{99m}Tc]-3 + 1-ergoline.

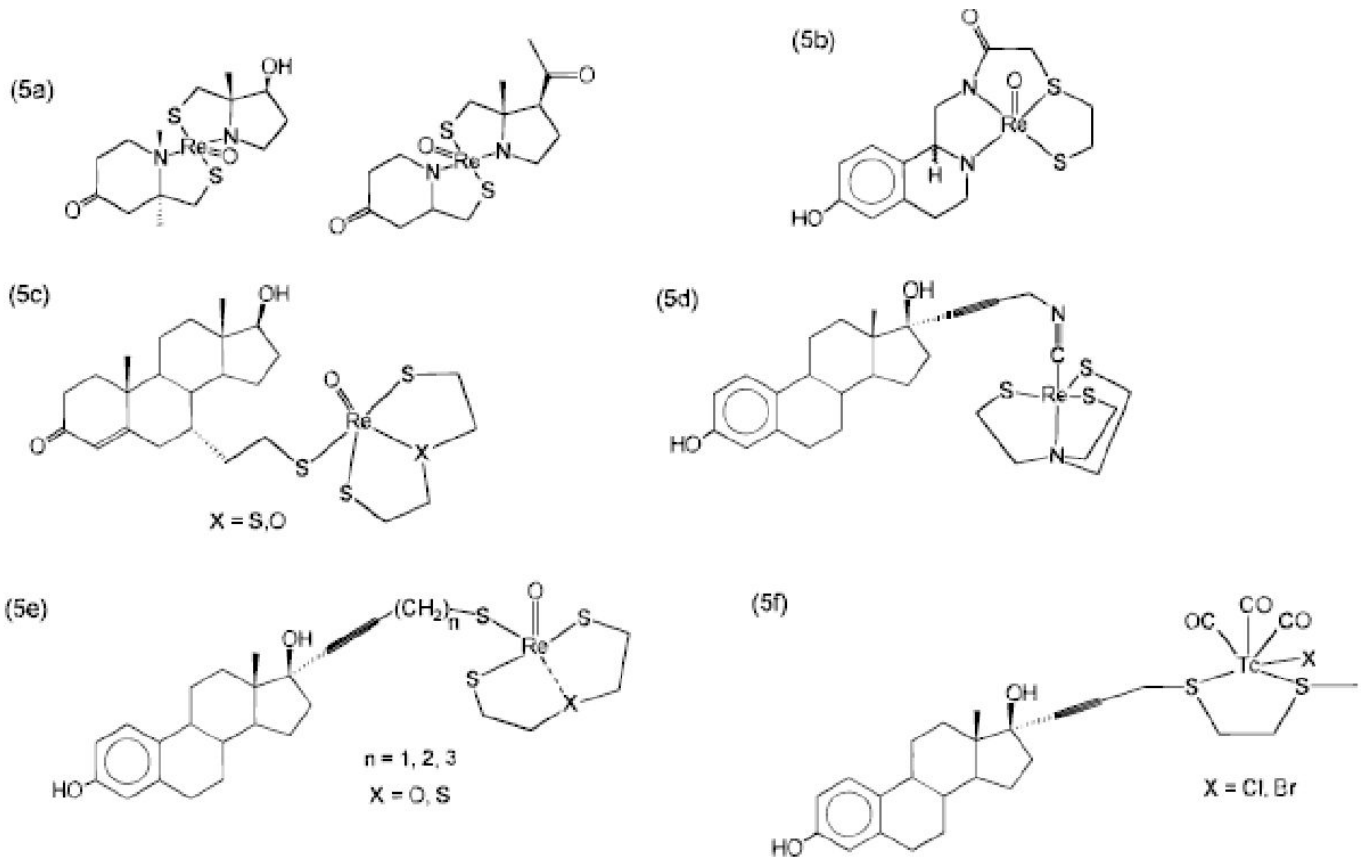
Метки на рецепторы серотонина



Метки для амилоидных бляшек

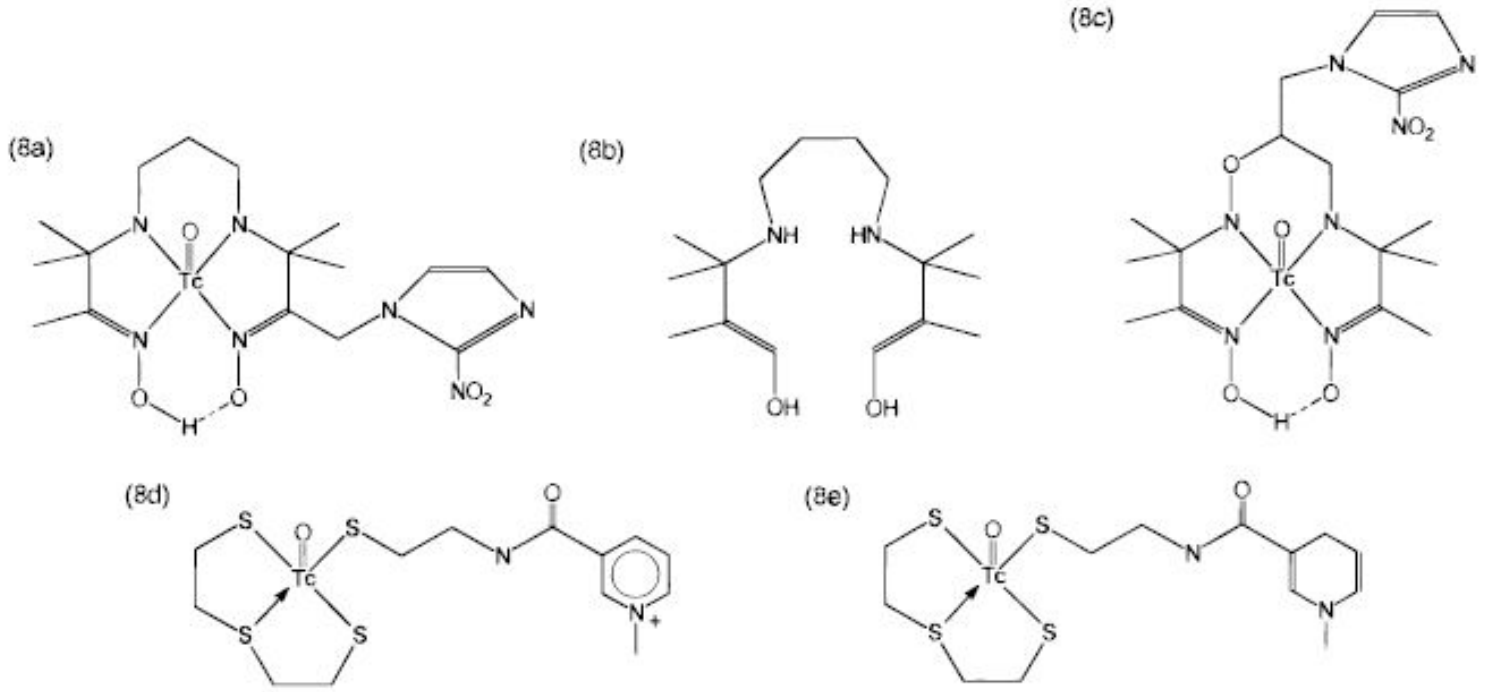


Метки гормональных рецепторов

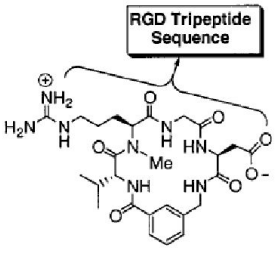


(a) прогестрон и андроген; (b) эстроген; (c) прогестрон; (d) -(f) эстроген

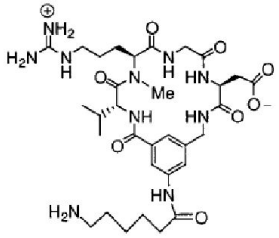
Метки для идентификации гипоксии



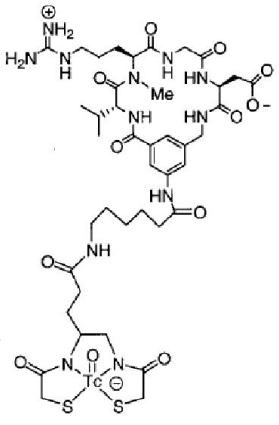
Некоторые клинически значимые белковые радиофармпрепараты, содержащие технеций



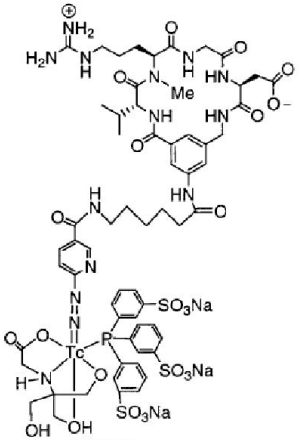
DMP757



XVO60



RP419



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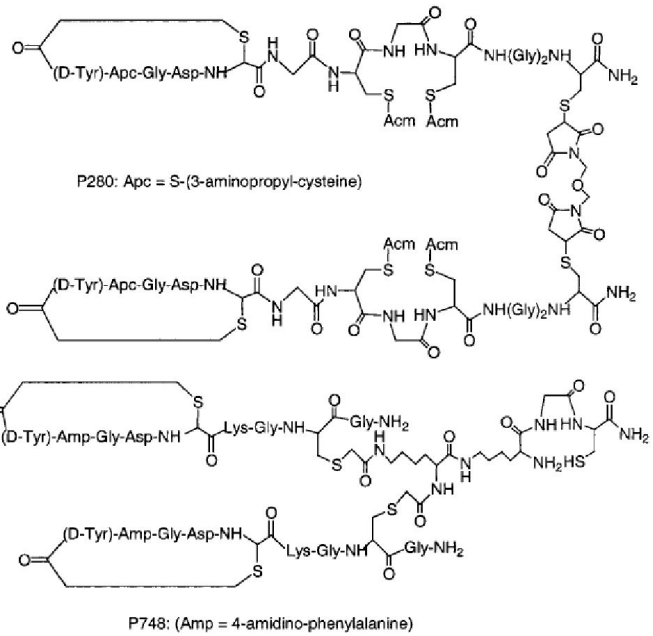
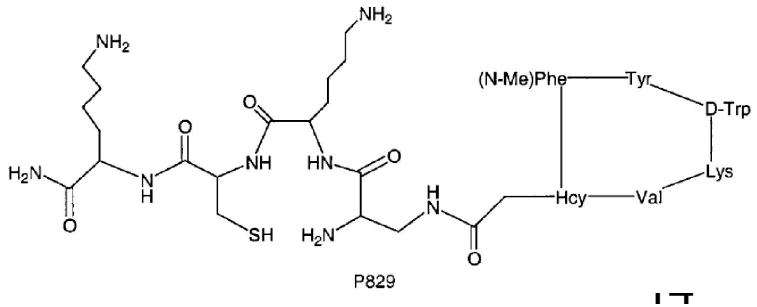




P829

Основные β-излучатели для лучевой терапии

radionuclide	$t_{1/2}$ (days)	max E_β (MeV)	γ-ray energy (MeV)
$^{32}P^{a}$	14.3	1.71	
$^{47}Sc^{b}$	3.4	0.6	0.159 (68%)
$^{64}Cu^{b}$	0.5	0.57	0.511 (38%)
$^{67}Cu^{b}$	2.6	0.57	0.184 (48%)
			0.092 (23%)
$^{89}Sr^{a}$	50.5	1.46	
$^{90}Y^{c}$	2.7	2.27	
$^{105}Rh^{a}$	1.5	0.57	0.319 (19%)
			0.306 (5%)
$^{111}Ag^{b}$	7.5	1.05	0.342 (6%)
$^{117m}Sn^{a}$	13.6	0.13	0.158 (87%)
$^{131}I^{a}$	8.0	0.81	0.364 (81%)
$^{149}Pm^{a}$	2.2	1.07	0.286 (3%)
$^{153}Sm^{a}$	1.9	0.8	0.103 (29%)
$^{166}Ho^{a}$	1.1	1.6	0.81 (6.33)
$^{177}Lu^{a}$	6.7	0.50	0.113 (6.4%)
			0.208 (11%)
$^{186}Re^{a}$	3.8	1.07	0.137 (9%)
$^{188}Re^{d}$	0.7	2.11	0.155 (15%)

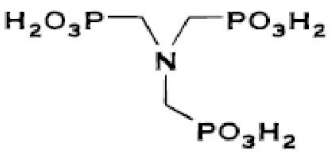
[а] – реактор

[б] – ускоритель

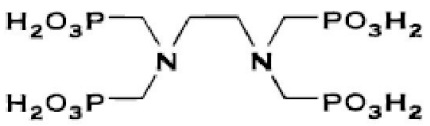
Основные α-излучатели для лучевой терапии

Нуклид	$t_{1/2}$	E_{α} (MeV)	E_{β} (MeV)	E_{γ} (MeV)
^{211}At	7.21 ч	5.9, 7.5		
^{212}Bi	1.01 ч	6.04, 6.08, 9.0	0.49, 0.56	
^{213}Bi	0.76 ч	5.9 (2%)	0.444 (98%)	

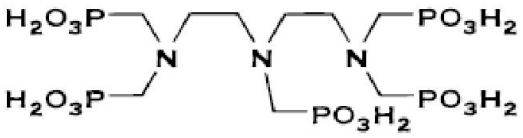
Лиганды, используемые при проведении лучевой терапии



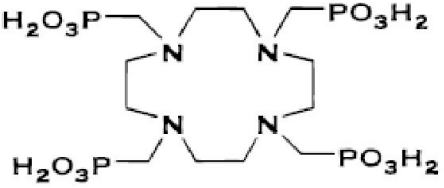
NTMP



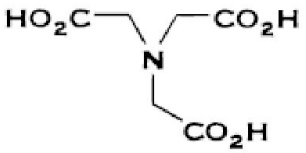
EDTMP



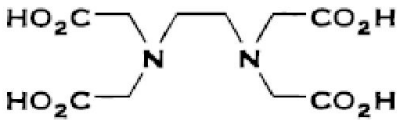
DTPMP



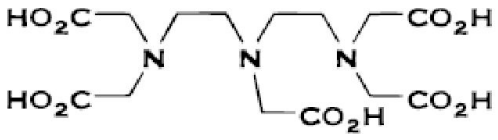
DOTMP



NTA



EDTA



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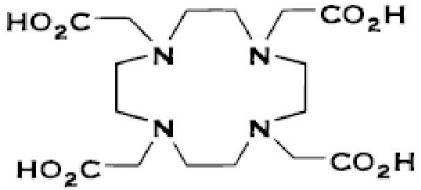

DOTA

Радиофармпрепараты для лечения опухолей костей

radiopharmaceutical	radionuclide		
	$t_{1/2}$ (days)	E_β (avg MeV)	max β^- range in tissue (mm)
^{89}Sr–chloride	50.5	0.58	6.7
^{32}P–orthophosphate	14.3	0.70	8.0
^{153}Sm–EDTMP	1.95	0.22	3.4
^{186}Re–HEDP	3.8	0.35	4.7
^{117m}Sn–DTPA	13.6	0.127, 0.129[a]	0.3[a]
^{166}Ho–DOTMP[b]	1.12	0.75	8.6