



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 07:41 AM UTC

PDB ID : 6VM9 / pdb\_00006vm9  
Title : T4H2 T cell receptor bound to HLA-A2 presenting gp100T2M peptide (IMDQVPFSV)  
Authors : Smith, A.R.; Baker, B.M.  
Deposited on : 2020-01-27  
Resolution : 2.90 Å (reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

---

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4-5-2 with Phenix2.0  
Xtrriage (Phenix) : 2.0  
EDS : 3.0  
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.49

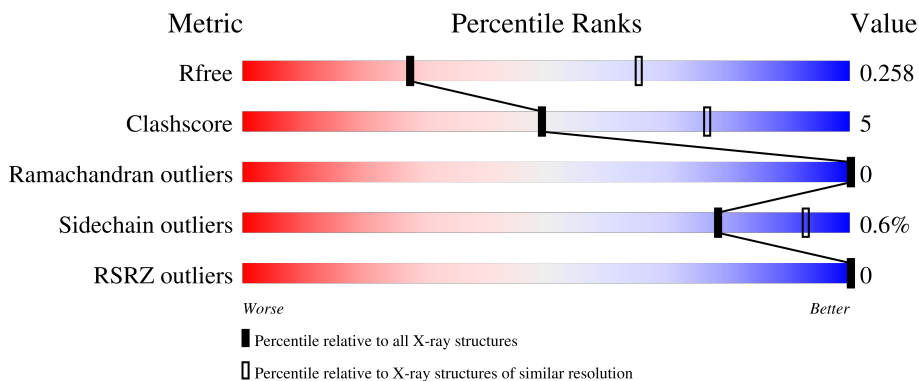
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.90 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	180053	2481 (2.90-2.90)
Clashscore	190562	2690 (2.90-2.90)
Ramachandran outliers	187476	2623 (2.90-2.90)
Sidechain outliers	187428	2625 (2.90-2.90)
RSRZ outliers	180081	2481 (2.90-2.90)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions  $\leq 5\%$ . The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	275	
2	B	100	
3	C	9	
4	D	206	
5	E	241	

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 6642 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called MHC class I antigen, A-2 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	275	2247	1403	409	426	9	0	0	0

- Molecule 2 is a protein called Beta-2-microglobulin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	100	837	533	141	159	4	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	1	MET	-	initiating methionine	UNP P61769

- Molecule 3 is a protein called Melanocyte protein PMEL.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
3	C	9	72	47	10	14	1	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	2	MET	THR	engineered mutation	UNP P40967

- Molecule 4 is a protein called T4H2 T cell receptor alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
4	D	201	1561	973	257	323	8	0	0	0

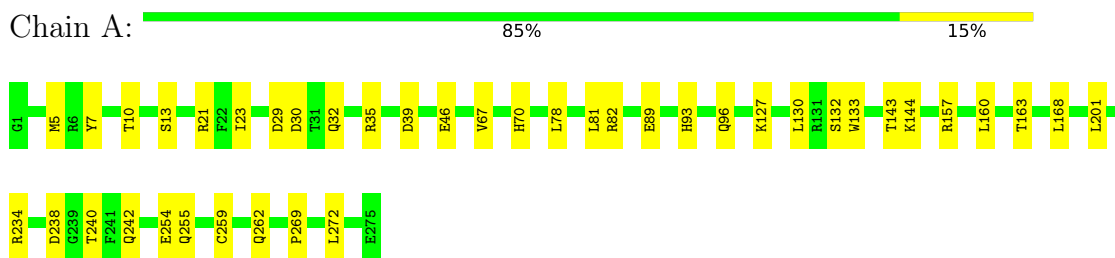
- Molecule 5 is a protein called T4H2 T cell receptor beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
5	E	240	1925	1216	330	372	7	0	0	0

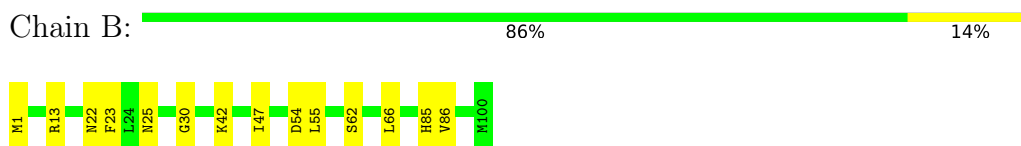
### 3 Residue-property plots

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

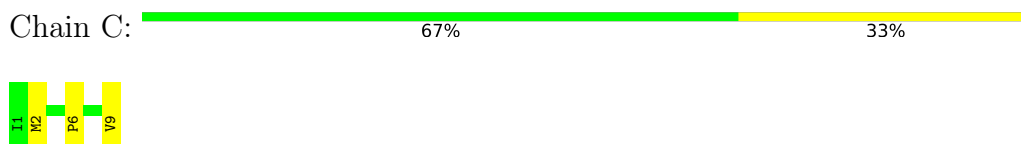
- Molecule 1: MHC class I antigen, A-2 alpha chain



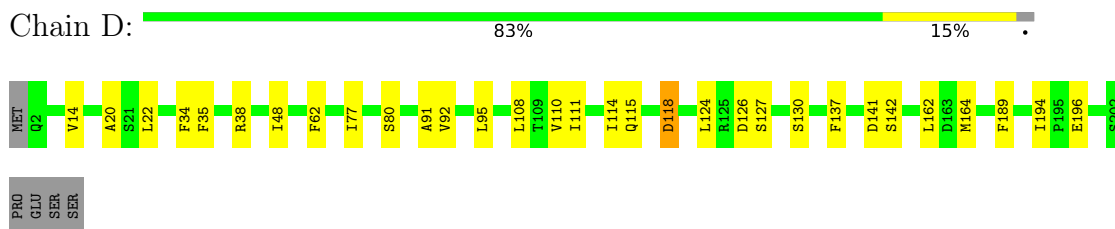
- Molecule 2: Beta-2-microglobulin



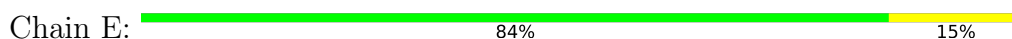
- Molecule 3: Melanocyte protein PMEL

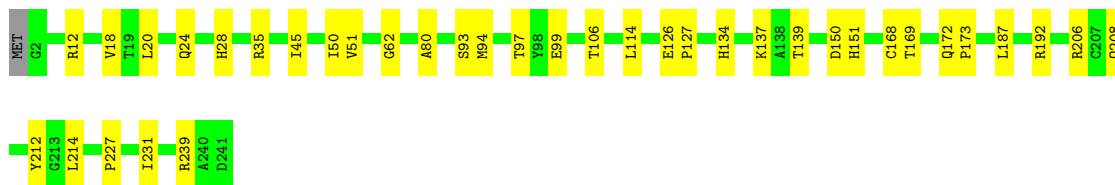


- Molecule 4: T4H2 T cell receptor alpha chain



- Molecule 5: T4H2 T cell receptor beta chain





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 64	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	129.74Å 129.74Å 113.44Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	42.70 – 2.90 42.70 – 2.90	Depositor EDS
% Data completeness (in resolution range)	92.1 (42.70-2.90) 92.1 (42.70-2.90)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.76 (at 2.90Å)	Xtrriage
Refinement program	PHENIX 1.13_2998, PHENIX 1.13_2998	Depositor
R, $R_{free}$	0.210 , 0.250 0.219 , 0.258	Depositor DCC
$R_{free}$ test set	1993 reflections (8.19%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	86.4	Xtrriage
Anisotropy	0.450	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 57.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.047 for h,-h-k,-l	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	6642	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	103.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.24% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 5 Model quality [i](#)

### 5.1 Standard geometry [i](#)

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# Z  >5	RMSZ	# Z  >5
1	A	0.15	0/2312	0.34	0/3137
2	B	0.09	0/860	0.26	0/1162
3	C	0.12	0/73	0.28	0/97
4	D	0.11	0/1594	0.28	0/2162
5	E	0.09	0/1978	0.27	0/2691
All	All	0.12	0/6817	0.30	0/9249

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2247	0	2096	26	0
2	B	837	0	803	9	0
3	C	72	0	73	3	0
4	D	1561	0	1468	20	0
5	E	1925	0	1820	26	0
All	All	6642	0	6260	70	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 5.

All (70) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
5:E:208:GLN:HG3	5:E:231:ILE:HD11	1.68	0.75
4:D:114:ILE:HD11	4:D:141:ASP:HA	1.71	0.70
5:E:24:GLN:OE1	5:E:28:HIS:N	2.27	0.68
5:E:137:LYS:HB3	5:E:192:ARG:HD2	1.77	0.67
4:D:118:ASP:OD2	5:E:134:HIS:NE2	2.28	0.66
1:A:5:MET:HB2	1:A:168:LEU:HD13	1.77	0.65
1:A:262:GLN:HG2	1:A:269:PRO:HB3	1.79	0.64
1:A:238:ASP:HB2	2:B:13:ARG:HD2	1.80	0.62
4:D:126:ASP:HB3	4:D:130:SER:H	1.63	0.62
1:A:130:LEU:O	1:A:157:ARG:NH1	2.32	0.61
1:A:259:CYS:HB3	1:A:272:LEU:HB2	1.83	0.60
5:E:126:GLU:OE2	5:E:239:ARG:NH1	2.34	0.57
4:D:35:PHE:HB2	4:D:91:ALA:HB3	1.87	0.55
5:E:172:GLN:HG3	5:E:173:PRO:HD2	1.90	0.54
1:A:127:LYS:HD2	1:A:132:SER:HB2	1.90	0.54
4:D:14:VAL:HG11	4:D:20:ALA:HB2	1.90	0.54
1:A:13:SER:HB3	1:A:78:LEU:HD13	1.90	0.54
5:E:139:THR:HG22	5:E:192:ARG:HB2	1.89	0.53
1:A:234:ARG:NH1	1:A:242:GLN:OE1	2.40	0.52
4:D:38:ARG:HB2	4:D:48:ILE:HD13	1.92	0.52
5:E:206:ARG:NH1	5:E:208:GLN:OE1	2.43	0.51
2:B:42:LYS:HB2	2:B:47:ILE:HD11	1.92	0.51
4:D:95:LEU:HD23	5:E:97:THR:HG21	1.92	0.51
1:A:32:GLN:NE2	2:B:54:ASP:OD2	2.34	0.50
5:E:139:THR:HA	5:E:192:ARG:HA	1.94	0.50
5:E:62:GLY:HA2	5:E:80:ALA:HB3	1.94	0.50
1:A:201:LEU:HD11	1:A:254:GLU:HB3	1.93	0.49
5:E:50:ILE:HG22	5:E:51:VAL:H	1.77	0.49
4:D:164:MET:SD	5:E:192:ARG:HG2	2.52	0.48
1:A:143:THR:HG21	3:C:9:VAL:HB	1.95	0.48
4:D:162:LEU:HB3	5:E:168:CYS:HB2	1.95	0.47
5:E:114:LEU:HD13	5:E:214:LEU:HD21	1.96	0.47
5:E:214:LEU:HD13	5:E:227:PRO:HG2	1.97	0.47
4:D:127:SER:HB2	5:E:126:GLU:HG3	1.97	0.47
2:B:25:ASN:HB3	2:B:66:LEU:HD11	1.96	0.46
2:B:22:ASN:OD1	2:B:23:PHE:N	2.41	0.46
1:A:5:MET:HE2	1:A:7:TYR:CE2	2.51	0.46
1:A:10:THR:HG22	1:A:96:GLN:HG2	1.97	0.46
4:D:115:GLN:OE1	4:D:115:GLN:N	2.47	0.46
1:A:35:ARG:NH2	1:A:46:GLU:OE1	2.43	0.46
1:A:81:LEU:HA	1:A:81:LEU:HD23	1.70	0.45
1:A:238:ASP:HB3	1:A:240:THR:HG22	1.97	0.45

*Continued on next page...*

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
5:E:35:ARG:HB3	5:E:45:ILE:HD11	1.97	0.45
1:A:21:ARG:HD2	1:A:39:ASP:OD2	2.16	0.45
1:A:23:ILE:HG21	2:B:55:LEU:HB3	1.99	0.45
4:D:194:ILE:HG22	4:D:196:GLU:H	1.81	0.45
5:E:150:ASP:OD1	5:E:150:ASP:N	2.47	0.45
5:E:93:SER:OG	5:E:99:GLU:O	2.35	0.45
1:A:133:TRP:HB2	1:A:144:LYS:HE3	1.98	0.44
5:E:169:THR:HG23	5:E:187:LEU:HD21	1.98	0.44
2:B:85:HIS:CD2	2:B:86:VAL:H	2.36	0.44
5:E:20:LEU:HD22	5:E:106:THR:HG21	1.98	0.44
1:A:67:VAL:HG13	3:C:2:MET:HE1	2.00	0.43
1:A:93:HIS:CE1	2:B:1:MET:HE2	2.52	0.43
4:D:34:PHE:HD2	4:D:92:VAL:HG22	1.83	0.43
4:D:137:PHE:HB2	4:D:189:PHE:CE2	2.54	0.43
4:D:22:LEU:HD21	4:D:108:LEU:HD12	1.99	0.42
4:D:62:PHE:HB3	4:D:77:ILE:HG12	2.01	0.42
1:A:21:ARG:HH21	1:A:23:ILE:HD11	1.83	0.42
1:A:70:HIS:CD2	3:C:6:PRO:HG3	2.54	0.42
5:E:12:ARG:HG3	5:E:18:VAL:HG22	2.02	0.42
2:B:30:GLY:HA2	2:B:62:SER:HB2	2.00	0.41
4:D:124:LEU:HD22	5:E:127:PRO:HA	2.02	0.41
4:D:35:PHE:CE1	5:E:99:GLU:HB3	2.56	0.41
1:A:255:GLN:H	1:A:255:GLN:HG3	1.76	0.41
5:E:151:HIS:HB3	5:E:212:TYR:HB2	2.02	0.41
1:A:82:ARG:HD2	1:A:89:GLU:OE2	2.21	0.40
4:D:80:SER:HB3	4:D:110:VAL:HG11	2.02	0.40
1:A:29:ASP:HB3	1:A:30:ASP:H	1.69	0.40
4:D:111:ILE:HG21	4:D:142:SER:HB3	2.02	0.40

There are no symmetry-related clashes.

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	273/275 (99%)	270 (99%)	3 (1%)	0	100	100
2	B	98/100 (98%)	95 (97%)	3 (3%)	0	100	100
3	C	7/9 (78%)	7 (100%)	0	0	100	100
4	D	199/206 (97%)	193 (97%)	6 (3%)	0	100	100
5	E	238/241 (99%)	235 (99%)	3 (1%)	0	100	100
All	All	815/831 (98%)	800 (98%)	15 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	231/231 (100%)	229 (99%)	2 (1%)	70	90
2	B	95/95 (100%)	95 (100%)	0	100	100
3	C	9/9 (100%)	9 (100%)	0	100	100
4	D	179/184 (97%)	178 (99%)	1 (1%)	78	93
5	E	209/210 (100%)	208 (100%)	1 (0%)	81	93
All	All	723/729 (99%)	719 (99%)	4 (1%)	78	93

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	160	LEU
1	A	163	THR
4	D	118	ASP
5	E	94	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	3	HIS

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type
1	A	197	HIS
5	E	151	HIS
5	E	210	GLN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

### 5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

### 5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

There are no ligands in this entry.

### 5.7 Other polymers [i](#)

There are no such residues in this entry.

### 5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

## 6 Fit of model and data [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95<sup>th</sup> percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å <sup>2</sup> )	Q<0.9
1	A	275/275 (100%)	-0.29	0 100 100	69, 93, 130, 165	0
2	B	100/100 (100%)	-0.31	0 100 100	74, 101, 133, 155	0
3	C	9/9 (100%)	0.07	0 100 100	83, 95, 104, 111	0
4	D	201/206 (97%)	-0.16	0 100 100	68, 110, 159, 182	0
5	E	240/241 (99%)	-0.18	0 100 100	69, 99, 130, 155	0
All	All	825/831 (99%)	-0.22	0 100 100	68, 99, 145, 182	0

There are no RSRZ outliers to report.

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

### 6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

### 6.4 Ligands [i](#)

There are no ligands in this entry.

### 6.5 Other polymers [i](#)

There are no such residues in this entry.