



Full wwPDB X-ray Structure Validation Report ⓘ

Apr 25, 2026 – 07:55 PM EDT

PDB ID : 5TOD / pdb_00005tod
Title : Transmembrane protein 24 SMP domain
Authors : Lees, J.A.; Reinisch, K.M.
Deposited on : 2016-10-17
Resolution : 2.96 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

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:

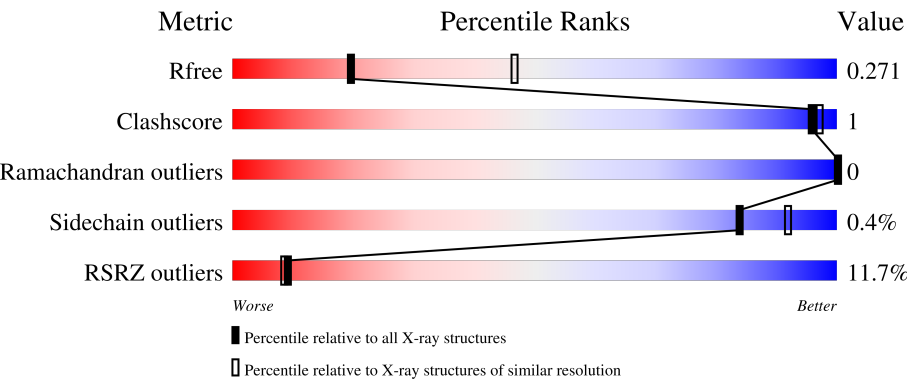
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.96 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	1130 (2.98-2.94)
Clashscore	190562	1157 (2.98-2.94)
Ramachandran outliers	187476	1101 (2.98-2.94)
Sidechain outliers	187428	1101 (2.98-2.94)
RSRZ outliers	180081	1130 (2.98-2.94)

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 ≥ 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	189	6% 78% 20%
1	B	189	6% 75% 5% 20%
1	C	189	11% 74% 24%
1	D	189	6% 79% 17%
1	E	189	13% 77% 20%

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Mol	Chain	Length	Quality of chain
1	F	189	13% 78% 21%

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 13570 atoms, of which 6670 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 Transmembrane protein 24.

Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
1	F	150	Total	C	H	N	O	S	Se	0	0	0
			2061	683	981	186	205	2	4			
1	A	152	Total	C	H	N	O	S	Se	0	0	0
			2364	756	1181	196	224	3	4			
1	B	152	Total	C	H	N	O	S	Se	0	0	0
			2360	756	1175	197	225	3	4			
1	C	144	Total	C	H	N	O	S	Se	0	0	0
			2159	692	1063	183	214	3	4			
1	D	157	Total	C	H	N	O	S	Se	0	0	0
			2414	776	1194	203	234	3	4			
1	E	152	Total	C	H	N	O	S	Se	0	0	0
			2212	720	1076	192	217	3	4			

There are 24 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	72	GLY	-	expression tag	UNP O14523
F	73	PRO	-	expression tag	UNP O14523
F	74	GLY	-	expression tag	UNP O14523
F	75	SER	-	expression tag	UNP O14523
A	72	GLY	-	expression tag	UNP O14523
A	73	PRO	-	expression tag	UNP O14523
A	74	GLY	-	expression tag	UNP O14523
A	75	SER	-	expression tag	UNP O14523
B	72	GLY	-	expression tag	UNP O14523
B	73	PRO	-	expression tag	UNP O14523
B	74	GLY	-	expression tag	UNP O14523
B	75	SER	-	expression tag	UNP O14523
C	72	GLY	-	expression tag	UNP O14523
C	73	PRO	-	expression tag	UNP O14523
C	74	GLY	-	expression tag	UNP O14523
C	75	SER	-	expression tag	UNP O14523
D	72	GLY	-	expression tag	UNP O14523

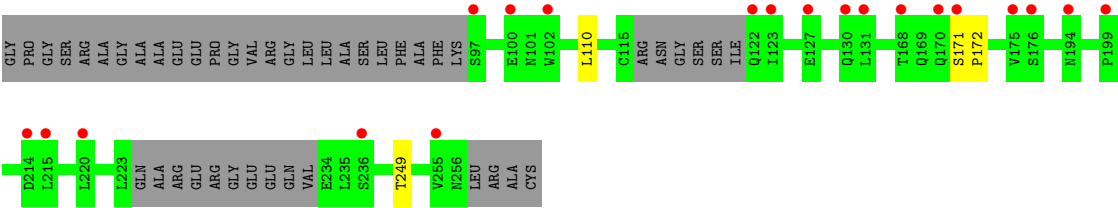
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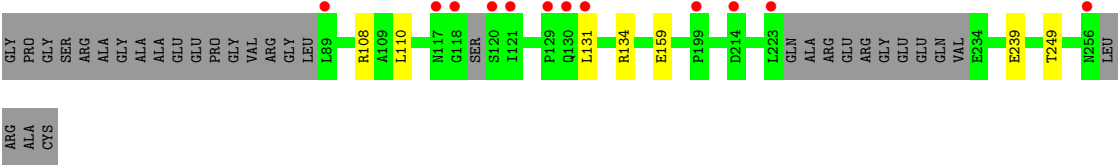
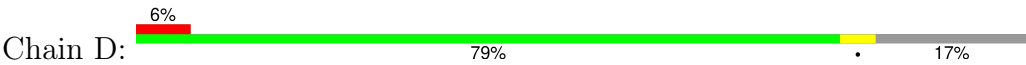
Chain	Residue	Modelled	Actual	Comment	Reference
D	73	PRO	-	expression tag	UNP O14523
D	74	GLY	-	expression tag	UNP O14523
D	75	SER	-	expression tag	UNP O14523
E	72	GLY	-	expression tag	UNP O14523
E	73	PRO	-	expression tag	UNP O14523
E	74	GLY	-	expression tag	UNP O14523
E	75	SER	-	expression tag	UNP O14523

- Molecule 1: Transmembrane protein 24

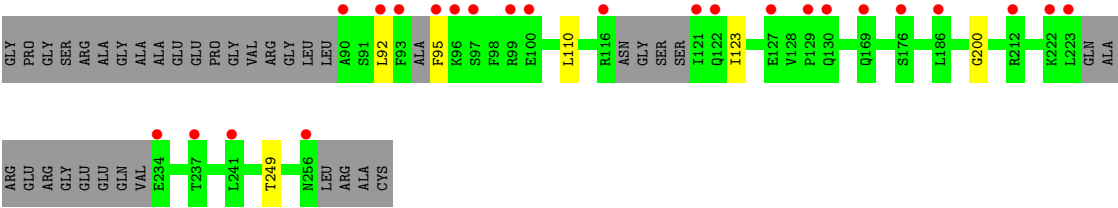
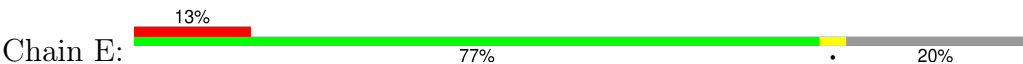




● Molecule 1: Transmembrane protein 24



● Molecule 1: Transmembrane protein 24



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	83.39Å 117.10Å 148.13Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	58.55 – 2.96 58.55 – 2.96	Depositor EDS
% Data completeness (in resolution range)	96.5 (58.55-2.96) 95.8 (58.55-2.96)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.38 (at 2.96Å)	Xtriage
Refinement program	PHENIX (1.10.1_2155: ???)	Depositor
R, R_{free}	0.239 , 0.264 0.245 , 0.271	Depositor DCC
R_{free} test set	1980 reflections (6.52%)	wwPDB-VP
Wilson B-factor (Å ²)	72.4	Xtriage
Anisotropy	0.500	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 66.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	13570	wwPDB-VP
Average B, all atoms (Å ²)	73.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.32% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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	0.11	0/1202	0.26	0/1634
1	B	0.11	0/1205	0.27	0/1638
1	C	0.11	0/1112	0.26	0/1514
1	D	0.12	0/1240	0.27	0/1685
1	E	0.11	0/1153	0.26	0/1571
1	F	0.11	0/1095	0.25	0/1491
All	All	0.11	0/7007	0.26	0/9533

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	1183	1181	1185	3	2
1	B	1185	1175	1179	5	0
1	C	1096	1063	1065	2	0
1	D	1220	1194	1210	4	2
1	E	1136	1076	1089	3	0
1	F	1080	981	983	1	0
All	All	6900	6670	6711	15	2

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 1.

All (15) 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)
1:A:130:GLN:OE1	1:A:130:GLN:N	2.27	0.67
1:D:134:ARG:NH2	1:D:159:GLU:OE2	2.29	0.64
1:E:92:LEU:O	1:E:95:PHE:N	2.45	0.50
1:C:110:LEU:HA	1:C:249:THR:HG21	1.94	0.49
1:B:110:LEU:HA	1:B:249:THR:HG21	1.96	0.47
1:D:108:ARG:NH1	1:E:200:GLY:O	2.47	0.47
1:B:146:SER:OG	1:B:147:GLU:N	2.48	0.47
1:F:110:LEU:HA	1:F:249:THR:HG21	1.97	0.45
1:D:110:LEU:HA	1:D:249:THR:HG21	2.00	0.44
1:A:126:GLU:OE2	1:B:99:ARG:NH1	2.52	0.43
1:C:171:SER:CB	1:C:172:PRO:HD2	2.49	0.42
1:E:110:LEU:HA	1:E:249:THR:HG21	2.02	0.42
1:B:207:TRP:CZ2	1:B:251:PRO:HB2	2.56	0.41
1:B:126:GLU:HB3	1:D:131:LEU:HD11	2.01	0.41
1:A:110:LEU:HA	1:A:249:THR:HG21	2.03	0.40

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:153:ARG:HH12	1:D:239:GLU:OE2[4_466]	1.44	0.16
1:A:153:ARG:NH1	1:D:239:GLU:OE2[4_466]	2.08	0.12

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	146/189 (77%)	138 (94%)	8 (6%)	0	100	100
1	B	146/189 (77%)	141 (97%)	5 (3%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	138/189 (73%)	134 (97%)	4 (3%)	0	100	100
1	D	151/189 (80%)	145 (96%)	6 (4%)	0	100	100
1	E	144/189 (76%)	138 (96%)	6 (4%)	0	100	100
1	F	142/189 (75%)	135 (95%)	7 (5%)	0	100	100
All	All	867/1134 (76%)	831 (96%)	36 (4%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

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	134/158 (85%)	134 (100%)	0	100	100
1	B	134/158 (85%)	132 (98%)	2 (2%)	57	76
1	C	122/158 (77%)	122 (100%)	0	100	100
1	D	138/158 (87%)	138 (100%)	0	100	100
1	E	122/158 (77%)	121 (99%)	1 (1%)	73	85
1	F	103/158 (65%)	103 (100%)	0	100	100
All	All	753/948 (79%)	750 (100%)	3 (0%)	84	92

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	170	GLN
1	B	218	THR
1	E	123	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	148	HIS

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Mol	Chain	Res	Type
1	C	148	HIS
1	D	103	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

6.1 Protein, DNA and RNA chains

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, 95th 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 ²)	Q<0.9
1	A	148/189 (78%)	0.52	11 (7%) 20 18	51, 69, 98, 123	0
1	B	148/189 (78%)	0.63	11 (7%) 20 18	49, 68, 95, 112	0
1	C	140/189 (74%)	0.85	20 (14%) 6 6	53, 71, 100, 111	0
1	D	153/189 (80%)	0.51	12 (7%) 19 17	48, 68, 99, 112	0
1	E	148/189 (78%)	1.04	24 (16%) 4 4	52, 72, 104, 122	0
1	F	146/189 (77%)	1.11	25 (17%) 4 3	60, 81, 106, 120	0
All	All	883/1134 (77%)	0.77	103 (11%) 9 8	48, 72, 102, 123	0

All (103) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	123	ILE	5.8
1	E	93	PHE	5.7
1	E	116	ARG	5.5
1	D	118	GLY	5.4
1	F	142	CYS	4.8
1	E	121	ILE	4.7
1	E	130	GLN	4.4
1	E	127	GLU	4.4
1	D	130	GLN	4.3
1	D	117	ASN	4.3
1	C	122	GLN	4.1
1	C	170	GLN	4.1
1	E	95	PHE	4.1
1	F	93	PHE	4.0
1	C	102	TRP	3.9
1	A	131	LEU	3.9
1	F	122	GLN	3.9
1	E	169	GLN	3.9
1	B	89	LEU	3.9

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Mol	Chain	Res	Type	RSRZ
1	E	222	LYS	3.8
1	E	97	SER	3.8
1	F	145	GLN	3.8
1	F	236	SER	3.7
1	B	130	GLN	3.7
1	B	255	VAL	3.6
1	F	144	ASP	3.6
1	F	131	LEU	3.6
1	F	121	ILE	3.4
1	E	90	ALA	3.3
1	F	143	VAL	3.3
1	E	100	GLU	3.3
1	D	120	SER	3.2
1	E	92	LEU	3.1
1	F	214	ASP	3.1
1	D	89	LEU	3.1
1	E	99	ARG	3.1
1	F	234	GLU	3.0
1	C	127	GLU	3.0
1	F	223	LEU	3.0
1	F	148	HIS	3.0
1	C	236	SER	2.9
1	C	123	ILE	2.9
1	A	148	HIS	2.9
1	E	234	GLU	2.8
1	A	214	ASP	2.8
1	C	214	ASP	2.8
1	F	169	GLN	2.7
1	C	130	GLN	2.7
1	A	147	GLU	2.7
1	E	176	SER	2.7
1	F	193	VAL	2.7
1	B	127	GLU	2.7
1	B	131	LEU	2.6
1	B	121	ILE	2.6
1	B	114	ALA	2.5
1	F	97	SER	2.5
1	C	97	SER	2.5
1	C	215	LEU	2.5
1	E	129	PRO	2.5
1	A	237	THR	2.5
1	F	247	VAL	2.5

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Mol	Chain	Res	Type	RSRZ
1	D	121	ILE	2.4
1	C	255	VAL	2.4
1	E	256	ASN	2.4
1	E	241	LEU	2.4
1	F	237	THR	2.4
1	A	89	LEU	2.4
1	B	199	PRO	2.4
1	C	199	PRO	2.4
1	A	137	ILE	2.4
1	D	131	LEU	2.4
1	C	171	SER	2.3
1	C	194	ASN	2.3
1	C	100	GLU	2.3
1	E	96	LYS	2.3
1	C	131	LEU	2.3
1	D	214	ASP	2.3
1	C	168	THR	2.3
1	E	212	ARG	2.3
1	C	220	LEU	2.2
1	E	186	LEU	2.2
1	E	122	GLN	2.2
1	F	128	VAL	2.2
1	F	91	SER	2.2
1	B	126	GLU	2.2
1	B	197	GLU	2.2
1	A	121	ILE	2.2
1	A	223	LEU	2.2
1	D	223	LEU	2.2
1	E	237	THR	2.2
1	F	103	GLN	2.1
1	F	154	CYS	2.1
1	A	130	GLN	2.1
1	F	137	ILE	2.1
1	C	176	SER	2.1
1	D	129	PRO	2.1
1	D	199	PRO	2.1
1	D	256	ASN	2.1
1	C	175	VAL	2.1
1	E	223	LEU	2.1
1	B	223	LEU	2.0
1	A	93	PHE	2.0
1	F	141	THR	2.0

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.