



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 09:44 AM UTC

PDB ID : 1S31 / pdb_00001s31
Title : Crystal Structure Analysis of the human Tub protein (isoform a) spanning residues 289 through 561
Authors : Boutboul, S.; Carroll, K.J.; Basdevant, A.; Gomez, C.; Nandrot, E.; Clement, K.; Shapiro, L.; Abitbol, M.
Deposited on : 2004-01-12
Resolution : 2.70 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

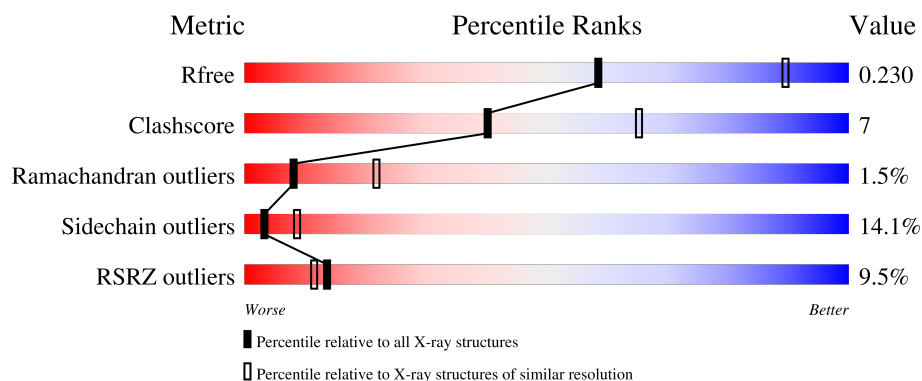
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.70 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	3538 (2.70-2.70)
Clashscore	190562	3843 (2.70-2.70)
Ramachandran outliers	187476	3778 (2.70-2.70)
Sidechain outliers	187428	3778 (2.70-2.70)
RSRZ outliers	180081	3538 (2.70-2.70)

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	273	10% 76% 18% 5%

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 2238 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.

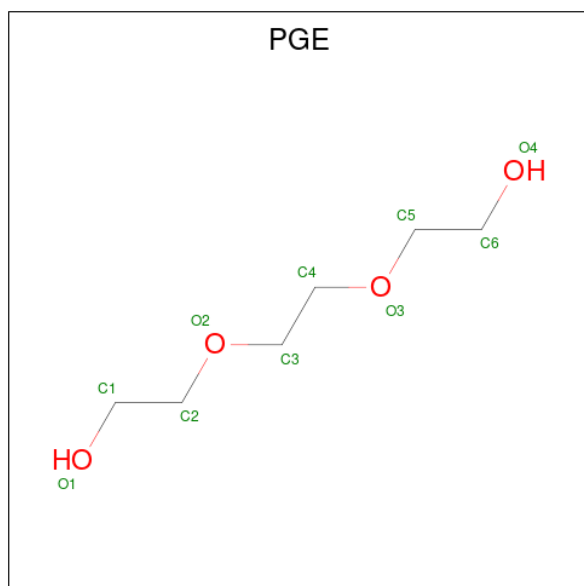
- Molecule 1 is a protein called tubby isoform a.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	273	2138	1342	378	406	12	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	336	PHE	TYR	conflict	UNP P50607

- Molecule 2 is TRIETHYLENE GLYCOL (CCD ID: PGE) (formula: C₆H₁₄O₄).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
2	A	1	10	6	4	0	0

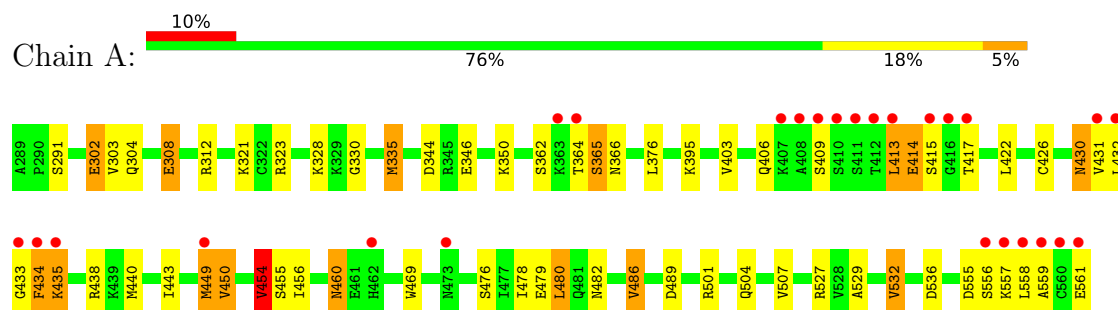
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	90	Total 90	O 90	0	0

3 Residue-property plots [i](#)

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: tubby isoform a



4 Data and refinement statistics

Property	Value	Source
Space group	I 2 3	Depositor
Cell constants a, b, c, α , β , γ	149.98Å 149.98Å 149.98Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	18.47 – 2.70 18.47 – 2.70	Depositor EDS
% Data completeness (in resolution range)	100.0 (18.47-2.70) 99.6 (18.47-2.70)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	8.14 (at 2.70Å)	Xtriage
Refinement program	REFMAC	Depositor
R, R_{free}	0.181 , 0.226 0.188 , 0.230	Depositor DCC
R_{free} test set	767 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å ²)	47.3	Xtriage
Anisotropy	0.000	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 53.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.029 for -l,-k,-h	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	2238	wwPDB-VP
Average B, all atoms (Å ²)	37.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.79% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: PGE

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	1.01	2/2180 (0.1%)	1.04	8/2952 (0.3%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	486	VAL	CA-CB	6.13	1.61	1.54
1	A	414	GLU	CA-C	5.33	1.57	1.52

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	450	VAL	N-CA-C	-6.09	106.49	111.91
1	A	431	VAL	N-CA-C	5.79	112.41	106.21
1	A	366	ASN	N-CA-C	5.61	117.79	108.99
1	A	558	LEU	N-CA-C	-5.55	104.25	111.74
1	A	403	VAL	N-CA-C	5.36	115.97	108.89
1	A	430	ASN	N-CA-C	5.32	116.36	108.86
1	A	415	SER	N-CA-C	5.25	117.16	108.13
1	A	414	GLU	N-CA-C	5.20	119.84	112.93

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	555	ASP	Peptide
1	A	557	LYS	Peptide

5.2 Too-close contacts

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	2138	0	2100	28	0
2	A	10	0	14	0	0
3	A	90	0	0	3	0
All	All	2238	0	2114	28	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 7.

All (28) 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:556:SER:O	1:A:559:ALA:HA	1.91	0.70
1:A:529:ALA:HB3	1:A:532:VAL:HG13	1.76	0.67
1:A:308:GLU:HB3	3:A:729:HOH:O	1.99	0.63
1:A:501:ARG:HD3	1:A:536:ASP:OD1	2.01	0.61
1:A:443:ILE:HD11	1:A:469:TRP:CD2	2.37	0.60
1:A:454:VAL:HG13	1:A:455:SER:H	1.69	0.58
1:A:395:LYS:NZ	1:A:426:CYS:SG	2.77	0.57
1:A:364:THR:O	1:A:365:SER:HB2	2.06	0.55
1:A:443:ILE:HD11	1:A:469:TRP:CE3	2.43	0.54
1:A:454:VAL:HG13	1:A:455:SER:N	2.23	0.54
1:A:504:GLN:OE1	1:A:527:ARG:HD3	2.07	0.54
1:A:312:ARG:NH1	3:A:729:HOH:O	2.41	0.53
1:A:330:GLY:O	1:A:335:MET:HB2	2.09	0.52
1:A:454:VAL:CG1	1:A:455:SER:N	2.72	0.52
1:A:561:GLU:CA	1:A:561:GLU:O	2.59	0.51
1:A:449:MET:HB3	3:A:724:HOH:O	2.11	0.51
1:A:302:GLU:HG3	1:A:303:VAL:H	1.78	0.48
1:A:478:ILE:HG22	1:A:480:LEU:HD13	1.95	0.48
1:A:460:ASN:N	1:A:460:ASN:ND2	2.63	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:449:MET:H	1:A:449:MET:HE2	1.82	0.44
1:A:321:LYS:NZ	1:A:346:GLU:OE1	2.51	0.44
1:A:556:SER:O	1:A:559:ALA:CA	2.63	0.43
1:A:449:MET:HE3	1:A:449:MET:HB2	1.97	0.43
1:A:433:GLY:O	1:A:435:LYS:N	2.52	0.42
1:A:460:ASN:N	1:A:460:ASN:HD22	2.18	0.42
1:A:344:ASP:OD2	1:A:501:ARG:NH2	2.47	0.41
1:A:330:GLY:O	1:A:335:MET:CB	2.69	0.41
1:A:440:MET:CG	1:A:482:ASN:HB3	2.51	0.41

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	271/273 (99%)	257 (95%)	10 (4%)	4 (2%)	8 22

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	365	SER
1	A	434	PHE
1	A	454	VAL
1	A	413	LEU

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	234/240 (98%)	201 (86%)	33 (14%)	3 9

All (33) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	291	SER
1	A	302	GLU
1	A	304	GLN
1	A	308	GLU
1	A	323	ARG
1	A	328	LYS
1	A	335	MET
1	A	350	LYS
1	A	362	SER
1	A	376	LEU
1	A	406	GLN
1	A	409	SER
1	A	413	LEU
1	A	414	GLU
1	A	417	THR
1	A	422	LEU
1	A	430	ASN
1	A	432	LEU
1	A	434	PHE
1	A	435	LYS
1	A	438	ARG
1	A	449	MET
1	A	450	VAL
1	A	454	VAL
1	A	456	ILE
1	A	460	ASN
1	A	476	SER
1	A	479	GLU
1	A	480	LEU
1	A	486	VAL
1	A	489	ASP
1	A	507	VAL
1	A	532	VAL

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

Mol	Chain	Res	Type
1	A	316	GLN
1	A	473	ASN
1	A	538	ASN

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](#)

1 ligand is modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
2	PGE	A	1	-	9,9,9	0.80	0	8,8,8	0.61	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	PGE	A	1	-	-	4/7/7/7	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	1	PGE	O1-C1-C2-O2
2	A	1	PGE	C3-C4-O3-C5
2	A	1	PGE	C1-C2-O2-C3
2	A	1	PGE	C6-C5-O3-C4

There are no ring outliers.

No monomer is involved in short contacts.

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	273/273 (100%)	0.18	26 (9%)	14 11	14, 31, 77, 91	0

All (26) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	413	LEU	6.8
1	A	558	LEU	5.9
1	A	408	ALA	5.7
1	A	409	SER	4.9
1	A	434	PHE	4.7
1	A	431	VAL	4.7
1	A	415	SER	4.6
1	A	412	THR	4.6
1	A	557	LYS	4.5
1	A	561	GLU	4.3
1	A	407	LYS	4.2
1	A	559	ALA	4.0
1	A	410	SER	3.6
1	A	560	CYS	3.3
1	A	417	THR	3.3
1	A	433	GLY	3.2
1	A	432	LEU	3.1
1	A	556	SER	2.8
1	A	462	HIS	2.8
1	A	449	MET	2.7
1	A	416	GLY	2.7
1	A	363	LYS	2.7
1	A	435	LYS	2.7
1	A	473	ASN	2.3
1	A	364	THR	2.3
1	A	411	SER	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](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	PGE	A	1	10/10	0.86	0.16	64,65,67,67	0

6.5 Other polymers [i](#)

There are no such residues in this entry.