



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 04:16 AM UTC

PDB ID : 2B9C / pdb_00002b9c
Title : Structure of tropomyosin's mid-region: bending and binding sites for actin
Authors : Brown, J.H.; Zhou, Z.; Reshetnikova, L.; Robinson, H.; Yammani, R.D.; Tobacman, L.S.; Cohen, C.
Deposited on : 2005-10-11
Resolution : 2.30 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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
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

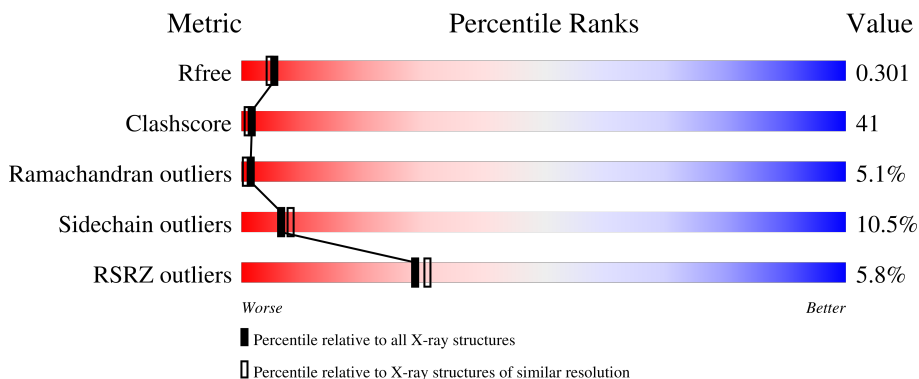
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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	6319 (2.30-2.30)
Clashscore	190562	6919 (2.30-2.30)
Ramachandran outliers	187476	6854 (2.30-2.30)
Sidechain outliers	187428	6854 (2.30-2.30)
RSRZ outliers	180081	6325 (2.30-2.30)

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	147	
1	B	147	

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 2650 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 striated-muscle alpha tropomyosin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	136	1151	701	211	236	3	0	8	0
1	B	142	1150	700	199	248	3	0	3	0

There are 54 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	88	MET	-	initiating methionine	UNP P04692
A	209	ASP	-	expression tag	UNP P04692
A	210	LYS	-	expression tag	UNP P04692
A	211	VAL	-	expression tag	UNP P04692
A	212	GLU	-	expression tag	UNP P04692
A	213	GLU	-	expression tag	UNP P04692
A	214	LEU	-	expression tag	UNP P04692
A	215	LEU	-	expression tag	UNP P04692
A	216	SER	-	expression tag	UNP P04692
A	217	LYS	-	expression tag	UNP P04692
A	218	ASN	-	expression tag	UNP P04692
A	219	TYR	-	expression tag	UNP P04692
A	220	HIS	-	expression tag	UNP P04692
A	221	LEU	-	expression tag	UNP P04692
A	222	GLU	-	expression tag	UNP P04692
A	223	ASN	-	expression tag	UNP P04692
A	224	GLU	-	expression tag	UNP P04692
A	225	VAL	-	expression tag	UNP P04692
A	226	ALA	-	expression tag	UNP P04692
A	227	ARG	-	expression tag	UNP P04692
A	228	LEU	-	expression tag	UNP P04692
A	229	LYS	-	expression tag	UNP P04692
A	230	LYS	-	expression tag	UNP P04692
A	231	LEU	-	expression tag	UNP P04692
A	232	VAL	-	expression tag	UNP P04692

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Chain	Residue	Modelled	Actual	Comment	Reference
A	233	GLY	-	expression tag	UNP P04692
A	234	GLU	-	expression tag	UNP P04692
B	1088	MET	-	initiating methionine	UNP P04692
B	1209	ASP	-	expression tag	UNP P04692
B	1210	LYS	-	expression tag	UNP P04692
B	1211	VAL	-	expression tag	UNP P04692
B	1212	GLU	-	expression tag	UNP P04692
B	1213	GLU	-	expression tag	UNP P04692
B	1214	LEU	-	expression tag	UNP P04692
B	1215	LEU	-	expression tag	UNP P04692
B	1216	SER	-	expression tag	UNP P04692
B	1217	LYS	-	expression tag	UNP P04692
B	1218	ASN	-	expression tag	UNP P04692
B	1219	TYR	-	expression tag	UNP P04692
B	1220	HIS	-	expression tag	UNP P04692
B	1221	LEU	-	expression tag	UNP P04692
B	1222	GLU	-	expression tag	UNP P04692
B	1223	ASN	-	expression tag	UNP P04692
B	1224	GLU	-	expression tag	UNP P04692
B	1225	VAL	-	expression tag	UNP P04692
B	1226	ALA	-	expression tag	UNP P04692
B	1227	ARG	-	expression tag	UNP P04692
B	1228	LEU	-	expression tag	UNP P04692
B	1229	LYS	-	expression tag	UNP P04692
B	1230	LYS	-	expression tag	UNP P04692
B	1231	LEU	-	expression tag	UNP P04692
B	1232	VAL	-	expression tag	UNP P04692
B	1233	GLY	-	expression tag	UNP P04692
B	1234	GLU	-	expression tag	UNP P04692

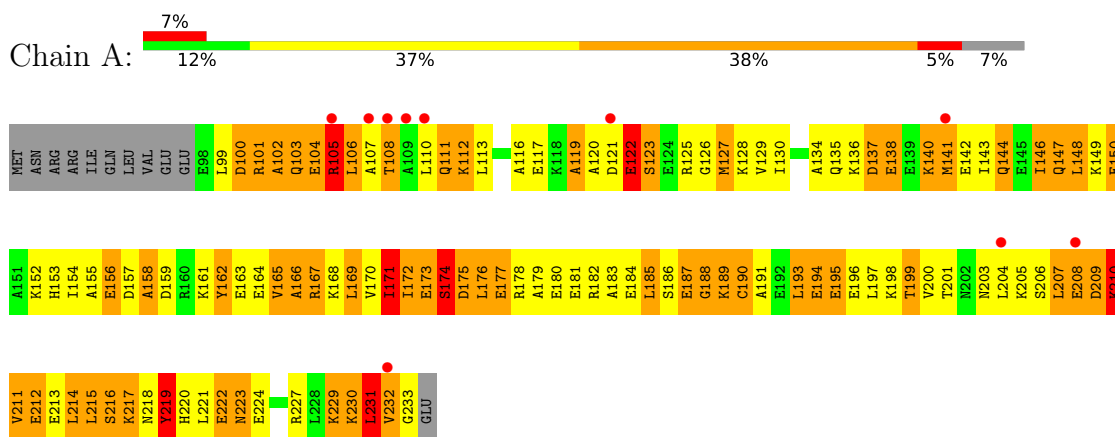
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	156	Total O 156 156	0	0
2	B	193	Total O 193 193	0	0

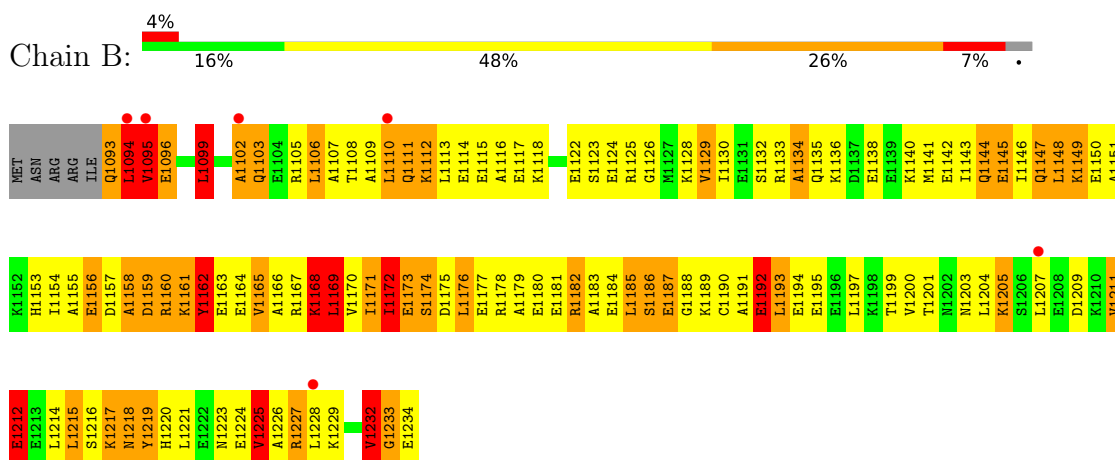
3 Residue-property plots [i](#)

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: striated-muscle alpha tropomyosin



- Molecule 1: striated-muscle alpha tropomyosin



4 Data and refinement statistics

Property	Value	Source
Space group	P 65	Depositor
Cell constants a, b, c, α , β , γ	80.52Å 80.52Å 112.45Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 2.30 20.00 – 2.30	Depositor EDS
% Data completeness (in resolution range)	96.8 (20.00-2.30) 96.7 (20.00-2.30)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.97 (at 2.30Å)	Xtrriage
Refinement program	CNS	Depositor
R, R_{free}	0.256 , 0.296 0.267 , 0.301	Depositor DCC
R_{free} test set	706 reflections (3.98%)	wwPDB-VP
Wilson B-factor (Å ²)	44.3	Xtrriage
Anisotropy	0.031	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 114.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.052 for h,-h-k,-l	Xtrriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	2650	wwPDB-VP
Average B, all atoms (Å ²)	63.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.86% 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	2.98	106/1156 (9.2%)	2.47	91/1543 (5.9%)
1	B	3.01	113/1153 (9.8%)	2.64	91/1539 (5.9%)
All	All	2.99	219/2309 (9.5%)	2.56	182/3082 (5.9%)

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	4
1	B	0	4
All	All	0	8

The worst 5 of 219 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	171	ILE	CA-CB	-14.89	1.37	1.54
1	B	1170	VAL	C-O	-13.71	1.08	1.24
1	B	1179	ALA	N-CA	-13.31	1.29	1.46
1	A	169	LEU	CA-C	-12.84	1.36	1.52
1	A	143	ILE	CA-C	12.29	1.68	1.52

The worst 5 of 182 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	1167	ARG	N-CA-C	-15.11	92.97	111.40
1	B	1099	LEU	N-CA-C	-13.60	96.77	113.50
1	A	104	GLU	N-CA-C	-13.12	97.25	113.38
1	A	178	ARG	NE-CZ-NH2	-12.39	108.05	119.20
1	B	1178	ARG	N-CA-C	12.11	124.48	111.28

There are no chirality outliers.

5 of 8 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	169	LEU	Mainchain
1	A	171	ILE	Mainchain
1	A	180	GLU	Mainchain
1	A	219	TYR	Sidechain
1	B	1162	TYR	Sidechain

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	1151	0	1130	108	0
1	B	1150	0	1120	111	0
2	A	156	0	0	11	0
2	B	193	0	0	11	0
All	All	2650	0	2250	189	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 41.

The worst 5 of 189 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:B:1171:ILE:CB	1:B:1171:ILE:CG2	1.75	1.60
1:B:1169:LEU:CD2	1:B:1169:LEU:CG	1.74	1.59
1:A:171:ILE:CD1	1:A:171:ILE:CG1	1.78	1.59
1:A:122[A]:GLU:HA	1:A:122[A]:GLU:OE1	1.51	1.11
1:A:141:MET:HE1	1:B:1140:LYS:HG2	1.37	1.05

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	142/147 (97%)	119 (84%)	15 (11%)	8 (6%)	1	0
1	B	143/147 (97%)	122 (85%)	15 (10%)	6 (4%)	2	1
All	All	285/294 (97%)	241 (85%)	30 (10%)	14 (5%)	1	1

5 of 14 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	102	ALA
1	A	103	GLN
1	A	210	LYS
1	A	231	LEU
1	B	1094	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	119/129 (92%)	107 (90%)	12 (10%)	7	9
1	B	120/129 (93%)	107 (89%)	13 (11%)	6	7
All	All	239/258 (93%)	214 (90%)	25 (10%)	6	8

5 of 25 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	1124	GLU

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Mol	Chain	Res	Type
1	B	1169	LEU
1	B	1212	GLU
1	B	1159	ASP
1	B	1172	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	144	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](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	B	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	B	1166:ALA	C	1167:ARG	N	1.20

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, 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	136/147 (92%)	0.56	10 (7%) 20 22	15, 68, 93, 101	8 (5%)
1	B	142/147 (96%)	0.34	6 (4%) 40 42	14, 66, 87, 98	3 (2%)
All	All	278/294 (94%)	0.44	16 (5%) 29 31	14, 67, 91, 101	11 (3%)

The worst 5 of 16 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	208	GLU	4.8
1	A	232	VAL	3.5
1	A	109	ALA	3.4
1	A	107	ALA	2.9
1	B	1095	VAL	2.9

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.