



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 12:27 AM UTC

PDB ID : 2SAS / pdb_00002sas
Title : STRUCTURE OF A SARCOPLASMIC CALCIUM-BINDING PROTEIN
FROM AMPHIOXUS REFINED AT 2.4 ANGSTROMS RESOLUTION
Authors : Cook, W.J.; Babu, Y.S.; Cox, J.A.
Deposited on : 1993-07-30
Resolution : 2.40 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
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

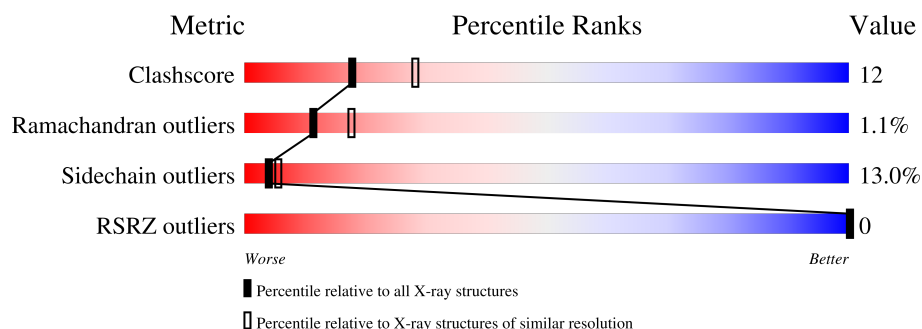
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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))
Clashscore	190562	5391 (2.40-2.40)
Ramachandran outliers	187476	5320 (2.40-2.40)
Sidechain outliers	187428	5321 (2.40-2.40)
RSRZ outliers	180081	4916 (2.40-2.40)

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	185	49% 38% 9% .

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 1499 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 SARCOPLASMIC CALCIUM-BINDING PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	185	Total	C	N	O	S	0	0	0
			1495	945	244	295	11			

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	3	Total	Ca	0	0
			3	3		

- Molecule 3 is water.

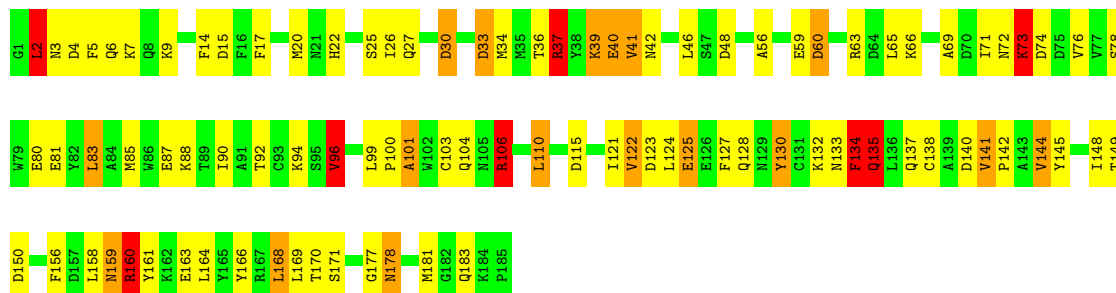
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	O	0	0
			1	1		

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: SARCOPLASMIC CALCIUM-BINDING PROTEIN

Chain A: 



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	59.60Å 81.30Å 82.40Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	5.00 – 2.40 5.00 – 2.40	Depositor EDS
% Data completeness (in resolution range)	(Not available) (5.00-2.40) 81.0 (5.00-2.40)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$	-	Xtriage
Refinement program	PROLSQ, X-PLOR	Depositor
R, R_{free}	0.199 , (Not available) 0.184 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	22.9	Xtriage
Anisotropy	0.347	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.43 , 72.0	EDS
L-test for twinning ¹	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	1499	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows:

¹Theoretical 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: CA

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	1.25	2/1527 (0.1%)	2.28	85/2059 (4.1%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	92	THR	CA-CB	6.05	1.62	1.53
1	A	22	HIS	CA-CB	5.10	1.61	1.53

All (85) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	40	GLU	CA-CB-CG	11.24	136.59	114.10
1	A	160	ARG	NE-CZ-NH2	11.13	129.22	119.20
1	A	121	ILE	CA-C-O	-10.61	109.09	120.76
1	A	27	GLN	CA-C-O	-10.37	110.13	121.23
1	A	134	PHE	CA-CB-CG	9.64	123.44	113.80
1	A	22	HIS	CA-CB-CG	-9.25	104.55	113.80
1	A	170	THR	N-CA-C	9.07	125.58	113.97
1	A	134	PHE	N-CA-C	-9.01	91.60	110.80
1	A	92	THR	CA-C-O	-8.58	112.28	121.20
1	A	15	ASP	N-CA-C	8.57	120.63	111.28
1	A	60	ASP	CA-CB-CG	8.18	120.78	112.60
1	A	17	PHE	CA-CB-CG	8.15	121.95	113.80
1	A	123	ASP	CA-C-O	-7.79	113.08	121.88
1	A	160	ARG	NE-CZ-NH1	-7.73	113.77	121.50
1	A	92	THR	N-CA-C	7.55	120.05	110.61
1	A	122	VAL	N-CA-CB	7.46	120.86	111.46
1	A	48	ASP	CA-CB-CG	7.38	119.98	112.60
1	A	132	LYS	CA-CB-CG	7.33	128.75	114.10
1	A	133	ASN	CA-C-N	7.31	135.51	121.54

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	133	ASN	C-N-CA	7.31	135.51	121.54
1	A	25	SER	CA-CB-OG	7.24	125.58	111.10
1	A	26	ILE	N-CA-CB	7.08	119.49	110.99
1	A	101	ALA	CA-C-O	-6.96	112.41	120.20
1	A	122	VAL	N-CA-C	-6.95	97.73	107.80
1	A	181	MET	N-CA-C	-6.92	104.45	113.17
1	A	22	HIS	N-CA-C	6.78	120.89	111.74
1	A	88	LYS	CA-CB-CG	6.71	127.53	114.10
1	A	2	LEU	CB-CA-C	6.64	121.53	109.37
1	A	59	GLU	CA-C-N	6.64	129.17	120.28
1	A	59	GLU	C-N-CA	6.64	129.17	120.28
1	A	134	PHE	O-C-N	6.51	131.25	122.59
1	A	128	GLN	CA-CB-CG	6.49	127.08	114.10
1	A	14	PHE	CA-CB-CG	6.46	120.26	113.80
1	A	130	TYR	CA-C-N	6.45	129.56	120.28
1	A	130	TYR	C-N-CA	6.45	129.56	120.28
1	A	135	GLN	CB-CG-CD	6.37	123.42	112.60
1	A	178	ASN	CA-CB-CG	6.30	118.90	112.60
1	A	39	LYS	CA-C-N	6.26	129.00	120.54
1	A	39	LYS	C-N-CA	6.26	129.00	120.54
1	A	123	ASP	O-C-N	6.26	130.56	122.23
1	A	96	VAL	N-CA-CB	6.17	118.93	110.54
1	A	150	ASP	CA-CB-CG	-6.16	106.44	112.60
1	A	183	GLN	OE1-CD-NE2	6.08	128.68	122.60
1	A	140	ASP	N-CA-C	-6.07	97.30	107.32
1	A	121	ILE	CA-C-N	-6.05	115.26	123.12
1	A	121	ILE	C-N-CA	-6.05	115.26	123.12
1	A	134	PHE	N-CA-CB	6.00	120.62	110.49
1	A	42	ASN	OD1-CG-ND2	5.99	128.59	122.60
1	A	159	ASN	CA-CB-CG	-5.98	106.62	112.60
1	A	92	THR	CA-CB-OG1	-5.96	100.66	109.60
1	A	2	LEU	N-CA-C	-5.95	100.48	109.95
1	A	14	PHE	N-CA-C	-5.91	104.53	110.97
1	A	71	ILE	CA-C-O	-5.90	114.82	120.95
1	A	25	SER	O-C-N	5.87	130.08	123.27
1	A	140	ASP	CB-CA-C	5.87	119.39	111.70
1	A	177	GLY	N-CA-C	-5.85	106.50	113.99
1	A	135	GLN	OE1-CD-NE2	-5.79	116.81	122.60
1	A	115	ASP	CA-CB-CG	5.76	118.36	112.60
1	A	37	ARG	O-C-N	5.72	127.96	122.07
1	A	132	LYS	N-CA-CB	5.69	119.15	110.39
1	A	34	MET	CA-C-N	5.68	127.83	120.44

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	34	MET	C-N-CA	5.68	127.83	120.44
1	A	37	ARG	CD-NE-CZ	5.67	132.33	124.40
1	A	33	ASP	CA-CB-CG	5.54	118.14	112.60
1	A	161	TYR	O-C-N	5.53	128.00	122.08
1	A	2	LEU	CA-C-O	-5.53	114.91	121.16
1	A	171	SER	O-C-N	5.53	127.62	121.43
1	A	73	LYS	N-CA-C	5.47	122.45	110.80
1	A	106	ARG	CA-CB-CG	5.45	125.01	114.10
1	A	72	ASN	CB-CG-ND2	5.31	124.36	116.40
1	A	161	TYR	CA-C-N	5.30	128.78	120.82
1	A	161	TYR	C-N-CA	5.30	128.78	120.82
1	A	125	GLU	CA-CB-CG	5.29	124.68	114.10
1	A	183	GLN	CB-CG-CD	-5.27	103.64	112.60
1	A	27	GLN	OE1-CD-NE2	5.19	127.79	122.60
1	A	90	ILE	N-CA-C	-5.19	105.48	110.72
1	A	41	VAL	CA-C-O	-5.16	114.51	119.92
1	A	177	GLY	O-C-N	-5.14	116.89	122.54
1	A	156	PHE	N-CA-CB	5.12	117.95	110.58
1	A	72	ASN	CA-CB-CG	-5.11	107.49	112.60
1	A	144	VAL	N-CA-C	-5.09	105.58	110.72
1	A	4	ASP	O-C-N	5.07	127.50	122.08
1	A	141	VAL	CB-CA-C	5.02	120.49	111.36
1	A	30	ASP	N-CA-C	-5.01	105.73	111.14
1	A	30	ASP	O-C-N	5.01	127.50	122.09

There are no chirality outliers.

There are no planarity outliers.

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	1495	0	1420	36	0
2	A	3	0	0	0	0
3	A	1	0	0	0	0
All	All	1499	0	1420	36	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 12.

All (36) 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:3:ASN:H	1:A:6:GLN:HE21	1.23	0.86
1:A:130:TYR:O	1:A:134:PHE:HB2	1.76	0.83
1:A:138:CYS:HB3	1:A:141:VAL:HG22	1.66	0.77
1:A:36:THR:O	1:A:40:GLU:HB2	1.91	0.71
1:A:9:LYS:HE3	1:A:168:LEU:O	1.94	0.67
1:A:2:LEU:HD22	1:A:87:GLU:HG2	1.75	0.66
1:A:56:ALA:O	1:A:60:ASP:HB2	2.01	0.61
1:A:100:PRO:O	1:A:103:CYS:HB2	2.02	0.58
1:A:148:ILE:O	1:A:160:ARG:NH1	2.38	0.57
1:A:78:SER:OG	1:A:81:GLU:HG3	2.08	0.54
1:A:5:PHE:CZ	1:A:9:LYS:HD3	2.44	0.53
1:A:148:ILE:HG23	1:A:164:LEU:HD11	1.91	0.52
1:A:65:LEU:CD1	1:A:85:MET:HE1	2.40	0.52
1:A:74:ASP:O	1:A:76:VAL:HG23	2.11	0.51
1:A:20:MET:HE2	1:A:20:MET:HA	1.94	0.50
1:A:73:LYS:N	1:A:73:LYS:HD3	2.27	0.50
1:A:3:ASN:H	1:A:6:GLN:NE2	2.03	0.49
1:A:159:ASN:O	1:A:163:GLU:HG3	2.13	0.49
1:A:9:LYS:HB3	1:A:168:LEU:HD22	1.95	0.49
1:A:127:PHE:O	1:A:130:TYR:HB3	2.13	0.48
1:A:101:ALA:HA	1:A:104:GLN:HG2	1.95	0.47
1:A:30:ASP:O	1:A:33:ASP:HB2	2.16	0.46
1:A:148:ILE:HA	1:A:160:ARG:HH12	1.80	0.46
1:A:80:GLU:H	1:A:80:GLU:CD	2.23	0.46
1:A:69:ALA:O	1:A:81:GLU:HB3	2.16	0.46
1:A:141:VAL:N	1:A:142:PRO:CD	2.79	0.46
1:A:96:VAL:HG23	1:A:166:TYR:HB2	1.99	0.45
1:A:145:TYR:CE2	1:A:149:THR:HG21	2.52	0.44
1:A:7:LYS:HG2	1:A:83:LEU:HD21	1.99	0.43
1:A:37:ARG:O	1:A:40:GLU:HB3	2.18	0.43
1:A:65:LEU:HD11	1:A:85:MET:HE1	2.01	0.43
1:A:106:ARG:HG3	1:A:110:LEU:HD22	2.00	0.43
1:A:144:VAL:O	1:A:148:ILE:HG13	2.19	0.42
1:A:73:LYS:HD3	1:A:73:LYS:H	1.83	0.42
1:A:5:PHE:HZ	1:A:178:ASN:HD21	1.67	0.41
1:A:135:GLN:O	1:A:137:GLN:NE2	2.54	0.40

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	183/185 (99%)	171 (93%)	10 (6%)	2 (1%)	11	18

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	134	PHE
1	A	135	GLN

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	162/162 (100%)	141 (87%)	21 (13%)	4	5

All (21) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	LEU
1	A	37	ARG
1	A	39	LYS
1	A	41	VAL
1	A	46	LEU
1	A	63	ARG
1	A	66	LYS
1	A	73	LYS
1	A	83	LEU

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Mol	Chain	Res	Type
1	A	94	LYS
1	A	96	VAL
1	A	99	LEU
1	A	106	ARG
1	A	110	LEU
1	A	122	VAL
1	A	124	LEU
1	A	125	GLU
1	A	158	LEU
1	A	160	ARG
1	A	168	LEU
1	A	169	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	6	GLN
1	A	27	GLN
1	A	42	ASN
1	A	159	ASN
1	A	178	ASN
1	A	183	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](#)

Of 3 ligands modelled in this entry, 3 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

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 [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	185/185 (100%)	-0.87	0 100 100	14, 20, 29, 32	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](#)

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(Å ²)	Q<0.9
2	CA	A	186	1/1	0.97	0.14	9,9,9,9	0
2	CA	A	187	1/1	0.98	0.14	11,11,11,11	0
2	CA	A	188	1/1	1.00	0.14	12,12,12,12	0

6.5 Other polymers [i](#)

There are no such residues in this entry.