



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 08:00 PM UTC

PDB ID : 2XOA / pdb_00002xoA
Title : Crystal Structure of the N-terminal three domains of the skeletal muscle Ryanodine Receptor (RyR1)
Authors : Tung, C.; Lobo, P.A.; Kimlicka, L.; Van Petegem, F.
Deposited on : 2010-08-10
Resolution : 2.50 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

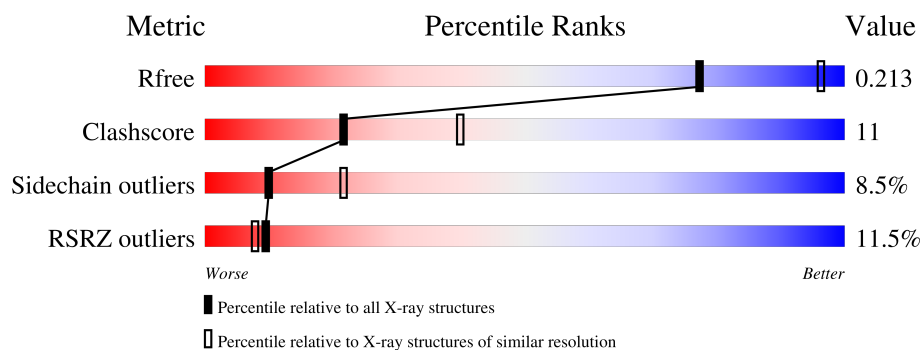
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.50 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	5829 (2.50-2.50)
Clashscore	190562	6492 (2.50-2.50)
Sidechain outliers	187428	6380 (2.50-2.50)
RSRZ outliers	180081	5833 (2.50-2.50)

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	559	9% 65% 15% • 18%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 3679 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 RYANODINE RECEPTOR 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	461	Total	C	N	O	S	0	1	0
			3558	2254	622	655	27			

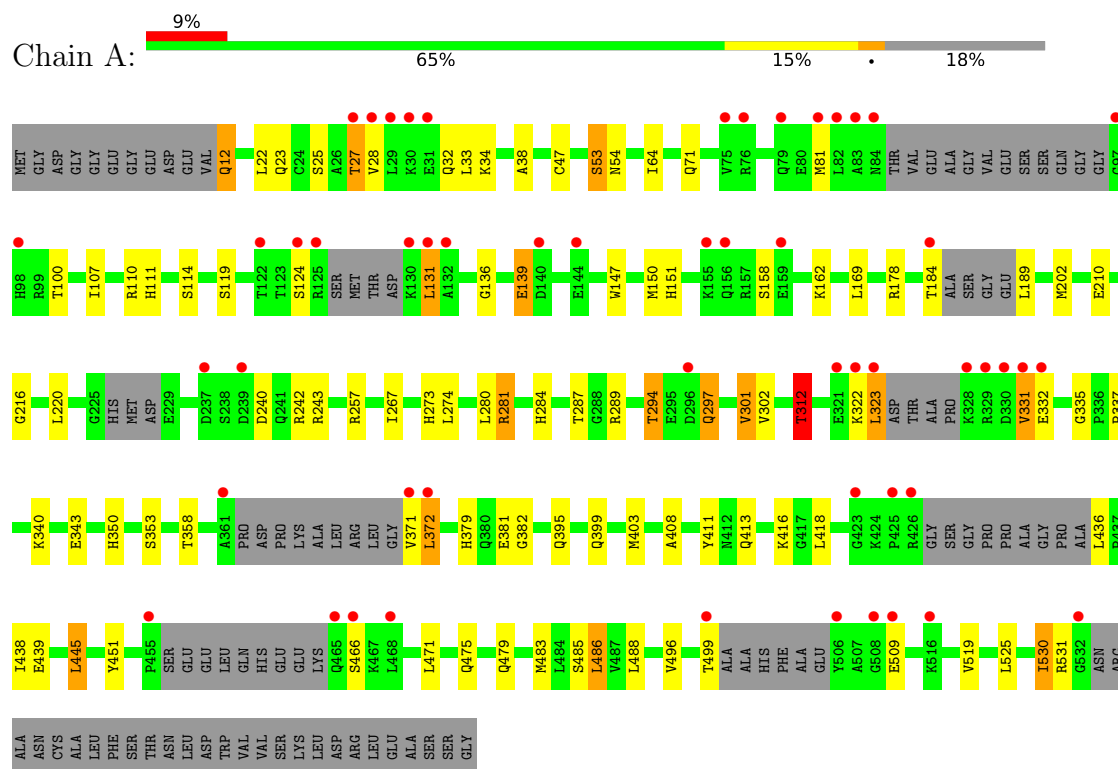
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	121	Total	O	0	0
			121	121		

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: RYANODINE RECEPTOR 1



4 Data and refinement statistics

Property	Value	Source
Space group	H 3 2	Depositor
Cell constants a, b, c, α , β , γ	170.80Å 170.80Å 301.20Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	49.45 – 2.50 49.45 – 2.50	Depositor EDS
% Data completeness (in resolution range)	100.0 (49.45-2.50) 85.1 (49.45-2.50)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.12 (at 2.51Å)	Xtriage
Refinement program	REFMAC 5.5.0072	Depositor
R, R_{free}	0.209 , 0.234 (Not available) , 0.213	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	45.2	Xtriage
Anisotropy	0.364	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 40.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	3679	wwPDB-VP
Average B, all atoms (Å ²)	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.62% 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 ⓘ

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	1/3625 (0.0%)	1.11	14/4904 (0.3%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	54	ASN	CA-C	5.21	1.60	1.52

All (14) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	530	ILE	CB-CA-C	-9.25	102.92	111.06
1	A	281	ARG	NE-CZ-NH2	-6.29	113.53	119.20
1	A	124	SER	N-CA-C	6.20	118.60	109.24
1	A	372	LEU	N-CA-C	5.84	119.07	110.30
1	A	216	GLY	N-CA-C	-5.52	105.47	112.54
1	A	509	GLU	N-CA-C	-5.49	105.71	112.90
1	A	119	SER	N-CA-C	5.42	117.65	109.41
1	A	267	ILE	N-CA-C	-5.36	106.44	111.48
1	A	395	GLN	N-CA-C	5.29	117.04	111.28
1	A	312	THR	N-CA-CB	-5.27	102.95	110.80
1	A	151	HIS	CA-C-N	5.25	125.01	119.76
1	A	151	HIS	C-N-CA	5.25	125.01	119.76
1	A	53	SER	N-CA-C	5.12	116.86	111.28
1	A	466	SER	N-CA-C	-5.06	106.86	112.57

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	3558	0	3485	76	0
2	A	121	0	0	6	0
All	All	3679	0	3485	76	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 11.

All (76) 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:12:GLN:HE21	1:A:12:GLN:HA	1.05	1.14
1:A:281:ARG:HD3	1:A:312:THR:CG2	1.77	1.13
1:A:281:ARG:HD3	1:A:312:THR:HG21	1.42	0.97
1:A:110:ARG:HD3	2:A:2015:HOH:O	1.70	0.89
1:A:12:GLN:HA	1:A:12:GLN:NE2	1.87	0.89
1:A:322:LYS:O	1:A:323:LEU:HD23	1.73	0.88
1:A:281:ARG:HD3	1:A:312:THR:HG23	1.59	0.83
1:A:257:ARG:HD3	2:A:2044:HOH:O	1.77	0.82
1:A:289:ARG:HB2	1:A:301:VAL:HG13	1.63	0.80
1:A:399:GLN:HG2	1:A:403:MET:CE	2.12	0.80
1:A:379:HIS:CD2	1:A:381:GLU:H	2.04	0.75
1:A:281:ARG:CD	1:A:312:THR:HG23	2.16	0.73
1:A:240:ASP:HB3	1:A:242:ARG:H	1.53	0.72
1:A:281:ARG:HG2	1:A:312:THR:HG23	1.71	0.72
1:A:399:GLN:HG2	1:A:403:MET:HE3	1.70	0.71
1:A:210:GLU:HG3	1:A:337:PRO:HG3	1.74	0.70
1:A:281:ARG:CD	1:A:312:THR:CG2	2.63	0.70
1:A:131:LEU:O	1:A:178:ARG:NH2	2.22	0.70
1:A:379:HIS:HD2	1:A:382:GLY:H	1.38	0.69
1:A:289:ARG:CB	1:A:301:VAL:HG13	2.23	0.68
1:A:322:LYS:O	1:A:323:LEU:CD2	2.42	0.67
1:A:22:LEU:HD21	1:A:202:MET:HE3	1.77	0.67
1:A:475:GLN:O	1:A:479:GLN:HG3	1.96	0.65
1:A:379:HIS:CD2	1:A:382:GLY:H	2.15	0.65
1:A:399:GLN:HG2	1:A:403:MET:HE2	1.80	0.64
1:A:281:ARG:CG	1:A:312:THR:HG23	2.28	0.62
1:A:12:GLN:HE21	1:A:12:GLN:CA	1.93	0.61
1:A:411:TYR:HB2	1:A:486:LEU:HD11	1.82	0.61
1:A:71:GLN:HG2	1:A:147:TRP:HH2	1.67	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:379:HIS:HD2	1:A:381:GLU:H	1.46	0.60
1:A:289:ARG:HB2	1:A:301:VAL:CG1	2.31	0.60
1:A:340:LYS:HD3	2:A:2077:HOH:O	2.00	0.59
1:A:257:ARG:O	1:A:284:HIS:HE1	1.85	0.59
1:A:399:GLN:CG	1:A:403:MET:HE2	2.32	0.58
1:A:294:THR:HG22	1:A:297:GLN:H	1.70	0.57
1:A:33:LEU:HD12	1:A:53:SER:HB2	1.86	0.57
1:A:243:ARG:HD2	2:A:2064:HOH:O	2.05	0.56
1:A:22:LEU:HD21	1:A:202:MET:CE	2.36	0.55
1:A:27:THR:HB	1:A:32:GLN:OE1	2.07	0.55
1:A:220:LEU:HD12	1:A:220:LEU:C	2.31	0.55
1:A:23:GLN:NE2	1:A:34:LYS:HD3	2.23	0.54
1:A:411:TYR:OH	1:A:445:LEU:HD13	2.08	0.53
1:A:107:ILE:HD11	1:A:202:MET:HE1	1.91	0.52
1:A:399:GLN:CG	1:A:403:MET:CE	2.87	0.52
1:A:436:LEU:HB3	1:A:438:ILE:CD1	2.41	0.51
1:A:107:ILE:CD1	1:A:202:MET:HE1	2.42	0.50
1:A:530:ILE:O	1:A:531:ARG:C	2.54	0.50
1:A:280:LEU:C	1:A:280:LEU:HD12	2.37	0.49
1:A:210:GLU:H	1:A:273:HIS:CE1	2.31	0.49
1:A:399:GLN:CD	1:A:403:MET:HE2	2.37	0.48
1:A:439:GLU:HB2	2:A:2102:HOH:O	2.13	0.48
1:A:210:GLU:H	1:A:273:HIS:HE1	1.62	0.48
1:A:284:HIS:HD2	1:A:287:THR:H	1.60	0.48
1:A:331:VAL:HG12	1:A:332:GLU:H	1.80	0.47
1:A:358:THR:HG21	1:A:382:GLY:HA2	1.97	0.47
1:A:100:THR:HG21	1:A:162:LYS:HD3	1.96	0.47
1:A:340:LYS:HE2	1:A:343:GLU:OE1	2.16	0.46
1:A:240:ASP:HB3	1:A:242:ARG:N	2.28	0.45
1:A:64:ILE:O	1:A:111:HIS:HE1	2.00	0.45
1:A:111:HIS:HD2	1:A:114:SER:OG	1.99	0.45
1:A:139:GLU:CD	1:A:139:GLU:H	2.25	0.45
1:A:273:HIS:HD2	1:A:335:GLY:O	2.00	0.44
1:A:289:ARG:HD2	2:A:2060:HOH:O	2.17	0.44
1:A:38:ALA:O	1:A:47:CYS:HA	2.18	0.44
1:A:294:THR:CG2	1:A:297:GLN:H	2.31	0.44
1:A:411:TYR:HB2	1:A:486:LEU:CD1	2.45	0.43
1:A:436:LEU:HB3	1:A:438:ILE:HD12	2.00	0.43
1:A:111:HIS:CD2	1:A:114:SER:H	2.36	0.43
1:A:403:MET:HE1	1:A:451:TYR:CE1	2.54	0.42
1:A:107:ILE:HG23	1:A:150:MET:HE2	2.00	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:408:ALA:HB2	1:A:483:MET:HE1	2.02	0.41
1:A:350:HIS:HD2	1:A:353:SER:H	1.67	0.41
1:A:399:GLN:O	1:A:403:MET:HG3	2.21	0.41
1:A:371:VAL:HG13	1:A:371:VAL:O	2.20	0.41
1:A:47:CYS:SG	1:A:136:GLY:HA2	2.61	0.40
1:A:220:LEU:HD12	1:A:220:LEU:O	2.20	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

There are no protein backbone outliers to report in this entry.

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	378/469 (81%)	346 (92%)	32 (8%)	10	22

All (32) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	12	GLN
1	A	25	SER
1	A	27	THR
1	A	28	VAL
1	A	81	MET
1	A	131	LEU
1	A	139	GLU
1	A	158	SER
1	A	169	LEU
1	A	184	THR

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Mol	Chain	Res	Type
1	A	189	LEU
1	A	274	LEU
1	A	294	THR
1	A	297	GLN
1	A	301	VAL
1	A	302	VAL
1	A	312	THR
1	A	323	LEU
1	A	331	VAL
1	A	372	LEU
1	A	413	GLN
1	A	416	LYS
1	A	418	LEU
1	A	445	LEU
1	A	471	LEU
1	A	485	SER
1	A	486	LEU
1	A	488	LEU
1	A	496	VAL
1	A	499	THR
1	A	519	VAL
1	A	525	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (15) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	12	GLN
1	A	23	GLN
1	A	54	ASN
1	A	84	ASN
1	A	111	HIS
1	A	151	HIS
1	A	224	HIS
1	A	273	HIS
1	A	284	HIS
1	A	308	HIS
1	A	350	HIS
1	A	379	HIS
1	A	383	HIS
1	A	489	ASN
1	A	520	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](#)

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	461/559 (82%)	0.51	53 (11%) 9 8	26, 51, 87, 115	1 (0%)

All (53) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	361	ALA	8.7
1	A	371	VAL	8.6
1	A	328	LYS	7.8
1	A	130	LYS	6.7
1	A	125	ARG	6.6
1	A	499	THR	6.2
1	A	465	GLN	5.9
1	A	323	LEU	5.3
1	A	29	LEU	5.3
1	A	76	ARG	4.5
1	A	97	GLY	4.4
1	A	140	ASP	4.3
1	A	184	THR	4.3
1	A	329	ARG	4.3
1	A	31	GLU	4.3
1	A	506	TYR	4.2
1	A	84	ASN	4.1
1	A	466	SER	4.1
1	A	83	ALA	4.0
1	A	426	ARG	3.9
1	A	27	THR	3.7
1	A	30	LYS	3.7
1	A	532	GLY	3.6
1	A	75	VAL	3.6
1	A	508	GLY	3.6
1	A	322	LYS	3.5
1	A	124	SER	3.3

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Mol	Chain	Res	Type	RSRZ
1	A	28	VAL	3.3
1	A	331	VAL	3.3
1	A	509	GLU	3.3
1	A	516	LYS	3.2
1	A	332	GLU	3.1
1	A	237	ASP	2.8
1	A	239	ASP	2.8
1	A	372	LEU	2.8
1	A	159	GLU	2.7
1	A	79	GLN	2.7
1	A	423	GLY	2.6
1	A	296	ASP	2.5
1	A	98	HIS	2.3
1	A	156	GLN	2.3
1	A	131	LEU	2.3
1	A	330	ASP	2.3
1	A	155	LYS	2.3
1	A	82	LEU	2.3
1	A	132	ALA	2.2
1	A	455	PRO	2.2
1	A	81	MET	2.1
1	A	468	LEU	2.1
1	A	425	PRO	2.1
1	A	122	THR	2.1
1	A	144	GLU	2.1
1	A	321	GLU	2.1

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.