



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 1, 2026 – 01:55 PM UTC

PDB ID : 1ACJ / pdb_00001acj
Title : QUATERNARY LIGAND BINDING TO AROMATIC RESIDUES IN THE
ACTIVE-SITE GORGE OF ACETYLCHOLINESTERASE
Authors : Sussman, J.L.; Harel, M.; Silman, I.
Deposited on : 1993-08-18
Resolution : 2.80 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

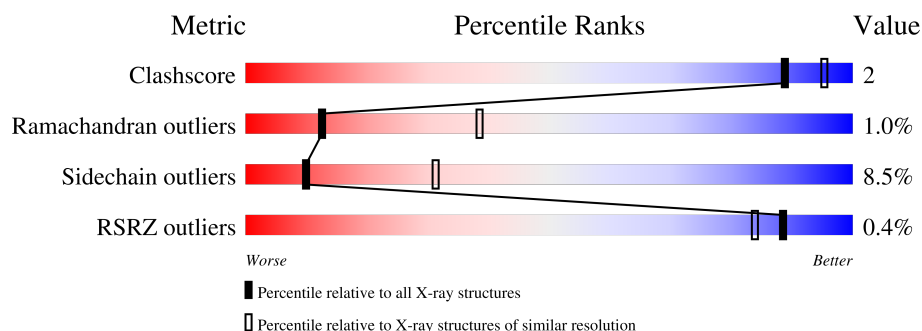
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.80 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	4276 (2.80-2.80)
Ramachandran outliers	187476	4196 (2.80-2.80)
Sidechain outliers	187428	4198 (2.80-2.80)
RSRZ outliers	180081	3869 (2.80-2.80)

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	537	

2 Entry composition [i](#)

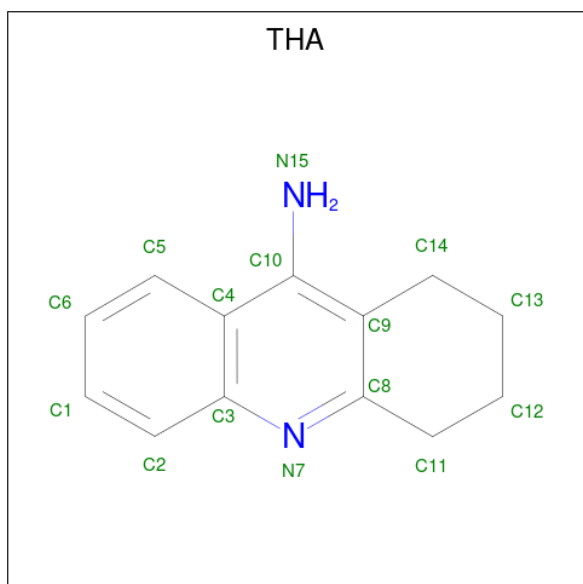
There are 3 unique types of molecules in this entry. The entry contains 4192 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 ACETYLCHOLINESTERASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	528	4095	2655	686	733	21	0	0	0

- Molecule 2 is TACRINE (CCD ID: THA) (formula: C₁₃H₁₄N₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	N		
2	A	1	15	13	2	0	0

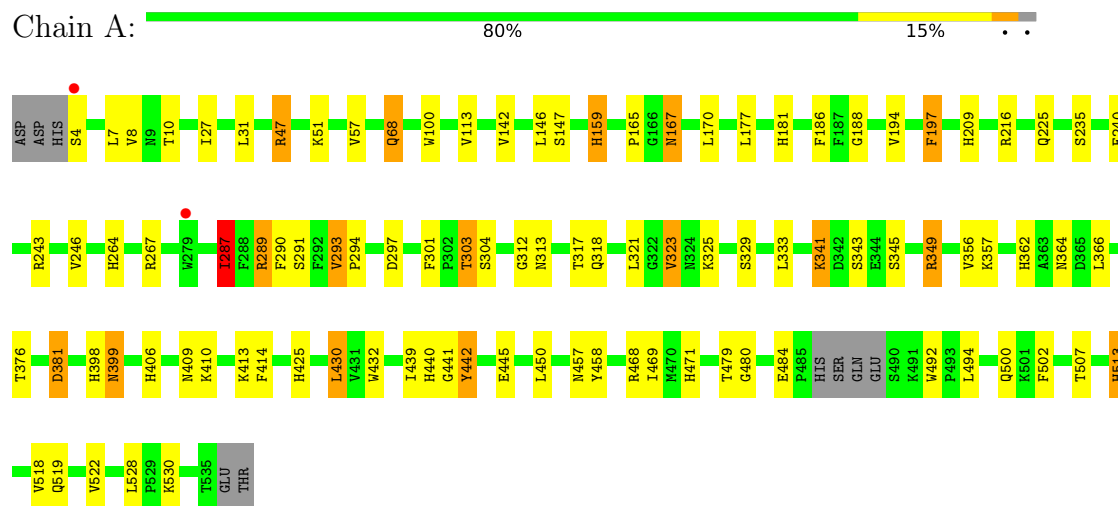
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	82	Total	O	0	0
			82	82		

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: ACETYLCHOLINESTERASE



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	113.70Å 113.70Å 138.10Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	8.00 – 2.80 8.00 – 2.86	Depositor EDS
% Data completeness (in resolution range)	(Not available) (8.00-2.80) 89.2 (8.00-2.86)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.35 (at 2.88Å)	Xtriage
Refinement program	X-PLOR	Depositor
R, R_{free}	0.195 , (Not available) 0.185 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	41.6	Xtriage
Anisotropy	0.379	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.23 , 58.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.017 for -h,-k,l	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	4192	wwPDB-VP
Average B, all atoms (Å ²)	21.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.25% 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: THA

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	12/4214 (0.3%)	1.56	41/5730 (0.7%)

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 (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	264	HIS	CG-CD2	6.20	1.42	1.35
1	A	398	HIS	CG-CD2	6.04	1.42	1.35
1	A	181	HIS	CG-CD2	6.02	1.42	1.35
1	A	209	HIS	CG-CD2	5.86	1.42	1.35
1	A	440	HIS	CG-CD2	5.85	1.42	1.35
1	A	513	HIS	CG-CD2	5.72	1.42	1.35
1	A	471	HIS	CG-CD2	5.51	1.42	1.35
1	A	406	HIS	CG-CD2	5.48	1.41	1.35
1	A	159	HIS	CG-CD2	5.46	1.41	1.35
1	A	425	HIS	CG-CD2	5.45	1.41	1.35
1	A	413	LYS	C-O	-5.22	1.17	1.24
1	A	362	HIS	CG-CD2	5.21	1.41	1.35

All (41) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	197	PHE	CA-CB-CG	9.18	122.98	113.80

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	293	VAL	N-CA-CB	-8.51	99.29	111.21
1	A	165	PRO	CA-C-N	-7.49	111.26	122.04
1	A	165	PRO	C-N-CA	-7.49	111.26	122.04
1	A	484	GLU	N-CA-C	-7.39	99.88	110.08
1	A	47	ARG	NE-CZ-NH2	-7.31	112.62	119.20
1	A	442	TYR	N-CA-C	7.15	121.86	113.20
1	A	507	THR	N-CA-C	6.62	120.82	112.87
1	A	325	LYS	N-CA-C	6.60	118.14	111.07
1	A	343	SER	N-CA-CB	-6.50	101.02	110.70
1	A	341	LYS	N-CA-C	6.08	117.90	111.28
1	A	165	PRO	N-CA-C	-6.07	102.34	111.57
1	A	381	ASP	CA-CB-CG	6.05	118.65	112.60
1	A	323	VAL	N-CA-CB	-5.96	101.33	112.36
1	A	399	ASN	N-CA-C	5.82	120.44	113.23
1	A	142	VAL	N-CA-C	-5.71	100.36	108.58
1	A	290	PHE	CA-CB-CG	-5.70	108.10	113.80
1	A	492	TRP	N-CA-C	-5.65	97.32	109.81
1	A	287	ILE	CA-CB-CG2	5.63	120.08	110.50
1	A	364	ASN	N-CA-C	-5.62	101.68	110.17
1	A	297	ASP	N-CA-C	5.59	120.09	113.16
1	A	409	ASN	CA-CB-CG	-5.55	107.05	112.60
1	A	188	GLY	CA-C-N	-5.55	116.39	122.38
1	A	188	GLY	C-N-CA	-5.55	116.39	122.38
1	A	457	ASN	CB-CA-C	-5.46	104.83	111.82
1	A	100	TRP	N-CA-C	-5.43	100.33	109.07
1	A	186	PHE	CA-CB-CG	-5.38	108.42	113.80
1	A	479	THR	N-CA-C	5.37	116.94	111.14
1	A	530	LYS	CB-CA-C	-5.34	101.92	110.79
1	A	301	PHE	N-CA-C	-5.33	100.25	109.15
1	A	287	ILE	CB-CA-C	5.30	118.51	110.62
1	A	10	THR	N-CA-C	-5.29	101.71	109.81
1	A	303	THR	CA-CB-CG2	5.25	119.43	110.50
1	A	147	SER	N-CA-C	-5.25	101.09	109.23
1	A	439	ILE	N-CA-C	5.22	116.76	109.55
1	A	4	SER	CB-CA-C	5.14	119.87	110.10
1	A	317	THR	N-CA-C	-5.14	101.60	108.34
1	A	494	LEU	N-CA-C	-5.12	103.63	110.55
1	A	480	GLY	CA-C-O	5.04	123.99	118.95
1	A	167	ASN	N-CA-C	5.01	118.68	112.47
1	A	345	SER	N-CA-C	5.00	121.45	110.80

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	442	TYR	Sidechain
1	A	458	TYR	Sidechain

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	4095	0	3909	15	0
2	A	15	0	14	1	0
3	A	82	0	0	1	0
All	All	4192	0	3923	15	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 2.

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:216:ARG:HH22	1:A:313:ASN:ND2	2.00	0.59
1:A:68:GLN:HA	1:A:68:GLN:HE21	1.76	0.50
1:A:303:THR:HG22	1:A:304:SER:H	1.76	0.50
1:A:468:ARG:HH11	1:A:468:ARG:HB3	1.78	0.49
1:A:445:GLU:HG3	3:A:655:HOH:O	2.13	0.48
1:A:502:PHE:CZ	1:A:513:HIS:HB2	2.48	0.48
1:A:441:GLY:HA3	2:A:999:THA:H112	1.97	0.47
1:A:349:ARG:HH21	1:A:376:THR:HG21	1.81	0.44
1:A:7:LEU:HD13	1:A:8:VAL:N	2.34	0.43
1:A:235:SER:HA	1:A:294:PRO:O	2.19	0.42
1:A:289:ARG:NH2	1:A:399:ASN:OD1	2.53	0.42
1:A:312:GLY:HA3	1:A:414:PHE:CD2	2.53	0.41
1:A:430:LEU:HD12	1:A:432:TRP:H	1.85	0.41
1:A:287:ILE:HD13	1:A:287:ILE:HA	1.94	0.41
1:A:113:VAL:CG1	1:A:146:LEU:HD21	2.52	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	524/537 (98%)	485 (93%)	34 (6%)	5 (1%)	12	38

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	159	HIS
1	A	167	ASN
1	A	381	ASP
1	A	500	GLN
1	A	329	SER

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	423/470 (90%)	387 (92%)	36 (8%)	10	31

All (36) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	27	ILE
1	A	31	LEU
1	A	47	ARG
1	A	51	LYS
1	A	57	VAL
1	A	68	GLN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	170	LEU
1	A	177	LEU
1	A	194	VAL
1	A	197	PHE
1	A	225	GLN
1	A	240	GLU
1	A	243	ARG
1	A	246	VAL
1	A	267	ARG
1	A	287	ILE
1	A	289	ARG
1	A	291	SER
1	A	293	VAL
1	A	318	GLN
1	A	321	LEU
1	A	323	VAL
1	A	333	LEU
1	A	341	LYS
1	A	349	ARG
1	A	356	VAL
1	A	357	LYS
1	A	366	LEU
1	A	410	LYS
1	A	430	LEU
1	A	450	LEU
1	A	469	ILE
1	A	518	VAL
1	A	519	GLN
1	A	522	VAL
1	A	528	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	59	ASN
1	A	181	HIS
1	A	313	ASN
1	A	409	ASN
1	A	416	ASN
1	A	519	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

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	THA	A	999	-	17,17,17	1.75	3 (17%)	22,24,24	1.47	3 (13%)

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	THA	A	999	-	-	-	0/3/3/3

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	999	THA	C14-C9	3.94	1.57	1.51
2	A	999	THA	C3-N7	-3.72	1.31	1.37
2	A	999	THA	C11-C8	2.97	1.55	1.50

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	999	THA	C8-N7-C3	4.16	122.60	117.67
2	A	999	THA	C9-C8-N7	-2.89	121.61	123.66
2	A	999	THA	C14-C9-C8	-2.60	118.45	120.90

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	999	THA	1	0

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	528/537 (98%)	-0.70	2 (0%) 88 84	3, 19, 41, 64	1 (0%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	4	SER	3.4
1	A	279	TRP	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](#)

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	THA	A	999	15/15	0.95	0.09	17,20,24,25	0

6.5 Other polymers [i](#)

There are no such residues in this entry.