



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 05:15 PM UTC

PDB ID : 2C4H / pdb_00002c4h
Title : Torpedo californica acetylcholinesterase in complex with 500mM acetylthiocholine
Authors : Colletier, J.P.; Fournier, D.; Greenblatt, H.M.; Sussman, J.L.; Zaccai, G.; Silman, I.; Weik, M.
Deposited on : 2005-10-19
Resolution : 2.15 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
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

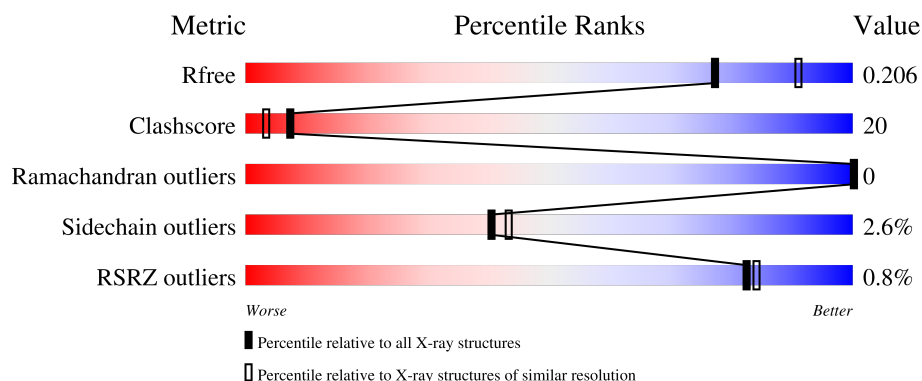
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.15 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	2057 (2.16-2.16)
Clashscore	190562	2159 (2.16-2.16)
Ramachandran outliers	187476	2134 (2.16-2.16)
Sidechain outliers	187428	2133 (2.16-2.16)
RSRZ outliers	180081	2059 (2.16-2.16)

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	74% 22% ...

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	NAG	A	1537	X	-	-	-

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	AT3	A	1540	-	-	X	-
4	AT3	A	1541	-	-	X	-

2 Entry composition [i](#)

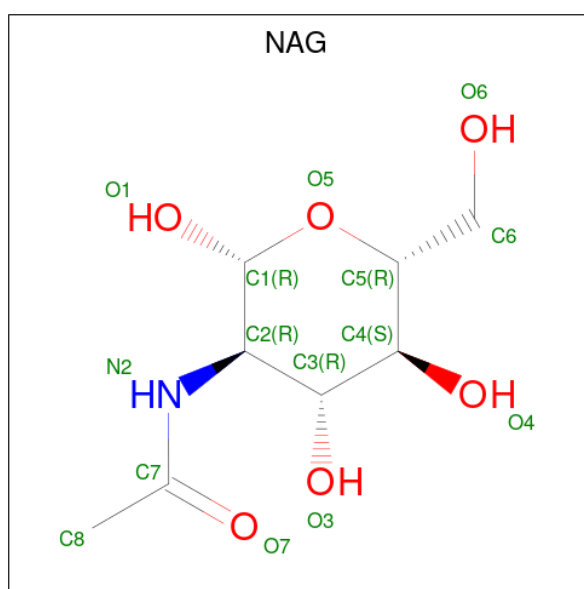
There are 8 unique types of molecules in this entry. The entry contains 5535 atoms, of which 0 are hydrogens and 0 are deuteriums.

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.

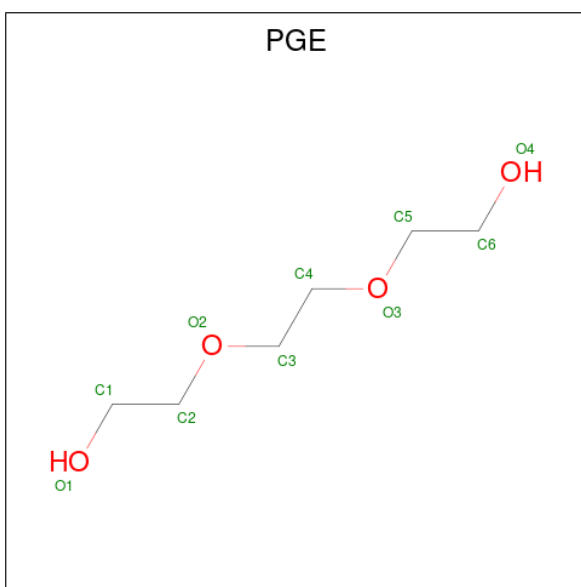
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	533	Total	C	N	O	S	0	29	1
			4501	2874	770	830	27			

- Molecule 2 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: $C_8H_{15}NO_6$).



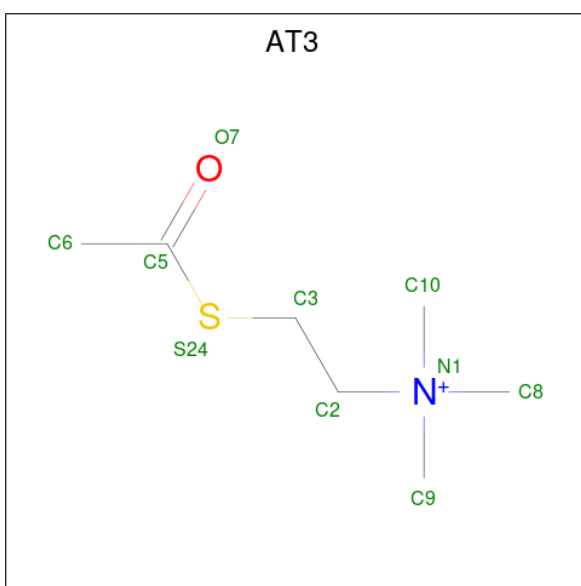
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			14	8	1	5		
2	A	1	Total	C	N	O	0	0
			14	8	1	5		

- Molecule 3 is TRIETHYLENE GLYCOL (CCD ID: PGE) (formula: $C_6H_{14}O_4$).



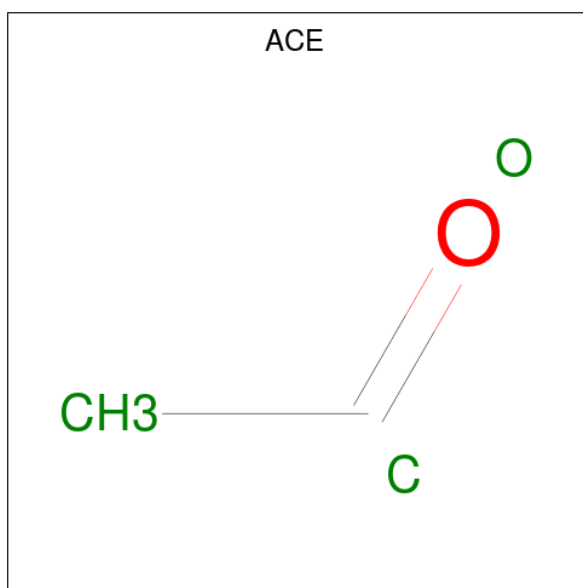
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			10	6	4		
3	A	1	Total	C	O	0	0
			10	6	4		

- Molecule 4 is ACETYLTHIOCHOLINE (CCD ID: AT3) (formula: $C_7H_{16}NOS$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	S	0	0
			10	7	1	1	1		
4	A	1	Total	C	N	O	S	0	0
			10	7	1	1	1		

- Molecule 5 is ACETYL GROUP (CCD ID: ACE) (formula: C_2H_4O).

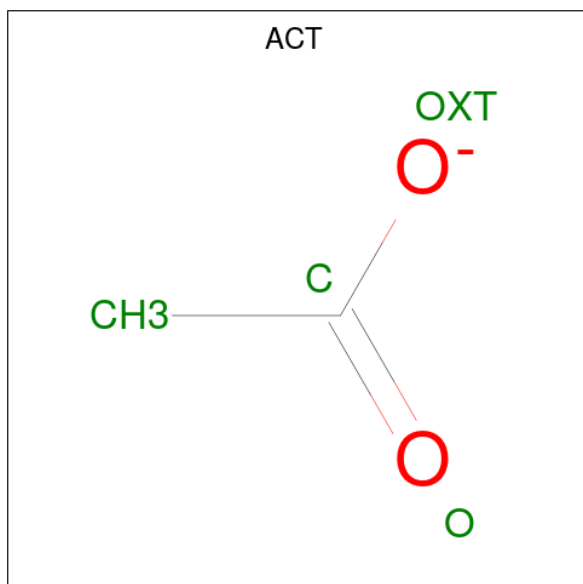


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	1
			3	2	1		

- Molecule 6 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	11	Total	Cl	0	0
			11	11		

- Molecule 7 is ACETATE ION (CCD ID: ACT) (formula: $C_2H_3O_2$).



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

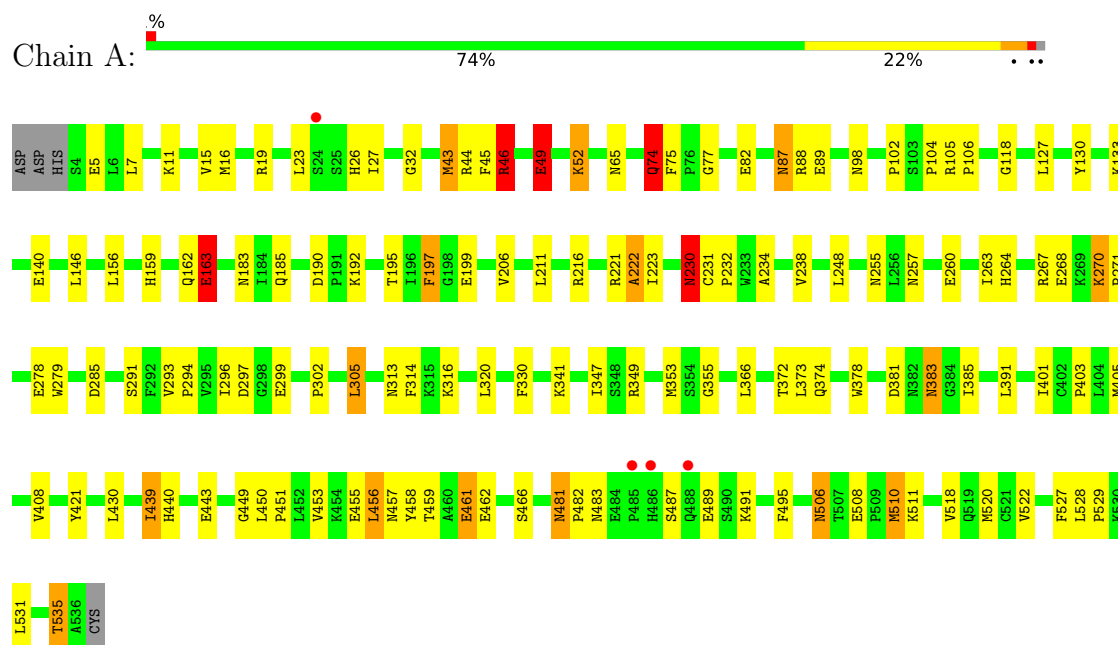
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	948	Total	O	0	0
			948	948		

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: ACETYLCHOLINESTERASE



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	111.99Å 111.99Å 137.12Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	19.80 – 2.15 19.80 – 2.15	Depositor EDS
% Data completeness (in resolution range)	99.5 (19.80-2.15) 99.4 (19.80-2.15)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.97 (at 2.16Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.169 , 0.209 0.165 , 0.206	Depositor DCC
R_{free} test set	2770 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å ²)	34.1	Xtriage
Anisotropy	0.493	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 93.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.027 for -h,-k,l	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	5535	wwPDB-VP
Average B, all atoms (Å ²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.74% 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: ACT, CL, AT3, NAG, PGE, ACE

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	4.50	19/4627 (0.4%)	1.43	46/6277 (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	7

The worst 5 of 19 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	46[A]	ARG	CZ-NH1	158.88	3.55	1.32
1	A	46[B]	ARG	CZ-NH1	158.88	3.55	1.32
1	A	49[A]	GLU	CD-OE1	132.75	3.77	1.25
1	A	49[B]	GLU	CD-OE1	132.75	3.77	1.25
1	A	43[A]	MET	SD-CE	38.69	2.76	1.79

The worst 5 of 46 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	49[A]	GLU	CG-CD-OE1	-37.02	33.26	118.40
1	A	49[B]	GLU	CG-CD-OE1	-37.02	33.26	118.40
1	A	46[A]	ARG	NE-CZ-NH1	-29.66	91.84	121.50
1	A	46[B]	ARG	NE-CZ-NH1	-29.66	91.84	121.50
1	A	270[A]	LYS	CG-CD-CE	-16.96	72.30	111.30

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	163[A]	GLU	Sidechain
1	A	230[A]	ASN	Sidechain
1	A	46[A]	ARG	Sidechain
1	A	49[A]	GLU	Sidechain
1	A	74[A]	GLN	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	4501	0	4318	177	0
2	A	28	0	26	0	0
3	A	20	0	28	2	0
4	A	20	0	32	32	0
5	A	3	0	3	0	0
6	A	11	0	0	1	0
7	A	4	0	3	1	0
8	A	948	0	0	17	2
All	All	5535	0	4410	185	2

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 20.

The worst 5 of 185 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:52[A]:LYS:CG	1:A:52[A]:LYS:CB	1.76	1.61
1:A:461[B]:GLU:CD	1:A:461[B]:GLU:CG	1.82	1.52
1:A:74[A]:GLN:CD	1:A:74[A]:GLN:CG	1.93	1.39
1:A:74[B]:GLN:OE1	1:A:74[B]:GLN:CD	1.75	1.28
1:A:163[A]:GLU:OE1	1:A:163[A]:GLU:CD	1.95	1.09

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
8:A:2342:HOH:O	8:A:2342:HOH:O[4_556]	1.71	0.49
8:A:2919:HOH:O	8:A:2919:HOH:O[4_556]	2.05	0.15

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	560/537 (104%)	538 (96%)	22 (4%)	0	100	100

There are no Ramachandran outliers to report.

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	494/469 (105%)	481 (97%)	13 (3%)	40	43

5 of 13 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	430	LEU
1	A	456	LEU
1	A	510[B]	MET
1	A	506	ASN
1	A	510[A]	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	514	GLN
1	A	525	ASN
1	A	324	ASN
1	A	362	HIS
1	A	374	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 19 ligands modelled in this entry, 11 are monoatomic - leaving 8 for Mogul analysis.

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	NAG	A	1537	1	14,14,15	0.92	1 (7%)	17,19,21	0.85	0
3	PGE	A	1539	-	9,9,9	0.90	1 (11%)	8,8,8	1.23	2 (25%)
2	NAG	A	1536	1	14,14,15	0.53	0	17,19,21	0.72	1 (5%)
5	ACE	A	1543[A]	1	1,2,2	1.02	0	0,1,1	-	-
4	AT3	A	1541	-	9,9,9	1.60	1 (11%)	12,12,12	0.46	0
3	PGE	A	1538	-	9,9,9	0.96	0	8,8,8	1.03	1 (12%)
4	AT3	A	1540	-	9,9,9	1.64	1 (11%)	12,12,12	0.59	0
7	ACT	A	1555[B]	-	3,3,3	2.02	1 (33%)	3,3,3	0.91	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	NAG	A	1537	1	1/1/5/7	6/6/23/26	0/1/1/1
3	PGE	A	1539	-	-	2/7/7/7	-
2	NAG	A	1536	1	-	0/6/23/26	0/1/1/1
4	AT3	A	1541	-	-	4/7/7/7	-
3	PGE	A	1538	-	-	0/7/7/7	-
4	AT3	A	1540	-	-	3/7/7/7	-

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1540	AT3	O7-C5	4.42	1.43	1.21
4	A	1541	AT3	O7-C5	4.35	1.43	1.21
2	A	1537	NAG	C1-C2	3.04	1.56	1.52
7	A	1555[B]	ACT	O-C	2.85	1.34	1.22
3	A	1539	PGE	O3-C5	2.01	1.50	1.42

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	1538	PGE	O2-C2-C1	2.30	120.23	110.11
3	A	1539	PGE	O3-C5-C6	2.21	119.87	110.11
2	A	1536	NAG	C2-N2-C7	-2.18	119.97	122.90
3	A	1539	PGE	O2-C3-C4	-2.00	101.23	110.35

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	A	1537	NAG	C1

5 of 15 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	1537	NAG	C8-C7-N2-C2
2	A	1537	NAG	O7-C7-N2-C2
4	A	1540	AT3	O7-C5-S24-C3
4	A	1540	AT3	C6-C5-S24-C3
4	A	1541	AT3	N1-C2-C3-S24

There are no ring outliers.

4 monomers are involved in 34 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	1539	PGE	2	0
4	A	1541	AT3	14	0
4	A	1540	AT3	18	0
7	A	1555[B]	ACT	1	0

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	A	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	230[B]:ASN	C	231[B]:CYS	N	0.99

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	533/537 (99%)	-0.42	4 (0%) 82 84	12, 33, 52, 84	29 (5%)

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	486	HIS	3.2
1	A	485	PRO	2.5
1	A	488	GLN	2.1
1	A	24	SER	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	NAG	A	1537	14/15	0.70	0.15	67,71,72,73	0
4	AT3	A	1541	10/10	0.84	0.20	81,82,83,84	0
3	PGE	A	1539	10/10	0.86	0.16	67,69,77,79	0

Continued on next page...

Continued from previous page...

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	NAG	A	1536	14/15	0.87	0.09	53,56,59,62	0
3	PGE	A	1538	10/10	0.88	0.12	48,57,60,60	0
6	CL	A	1548	1/1	0.88	0.10	69,69,69,69	0
6	CL	A	1549	1/1	0.88	0.19	88,88,88,88	0
6	CL	A	1554	1/1	0.89	0.13	75,75,75,75	0
6	CL	A	1550	1/1	0.90	0.15	80,80,80,80	0
4	AT3	A	1540	10/10	0.91	0.19	76,77,78,79	0
6	CL	A	1546	1/1	0.92	0.09	58,58,58,58	0
6	CL	A	1547	1/1	0.93	0.12	82,82,82,82	0
6	CL	A	1553	1/1	0.94	0.08	69,69,69,69	0
6	CL	A	1551	1/1	0.94	0.13	79,79,79,79	0
5	ACE	A	1543[A]	3/3	0.95	0.07	32,32,38,39	3
6	CL	A	1552	1/1	0.95	0.16	82,82,82,82	0
7	ACT	A	1555[B]	4/4	0.95	0.07	19,20,21,23	4
6	CL	A	1544	1/1	0.96	0.08	49,49,49,49	0
6	CL	A	1545	1/1	1.00	0.04	35,35,35,35	0

6.5 Other polymers ⓘ

There are no such residues in this entry.