



Full wwPDB X-ray Structure Validation Report ⓘ

May 5, 2020 – 01:51 PM EDT

PDB ID : 4PW4
Title : Crystal structure of Aminopeptidase N in complex with phosphonic acid analogue of homophenylalanine L-(R)-hPheP
Authors : Nocek, B.; Mulligan, R.; Vassiliou, S.; Berlicki, L.; Mucha, A.; Joachimiak, A.; Midwest Center for Structural Genomics (MCSG)
Deposited on : 2014-03-18
Resolution : 1.85 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 following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.10.1
Percentile statistics : 20171227.v01 (using entries in the PDB archive December 27th 2017)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.10.1

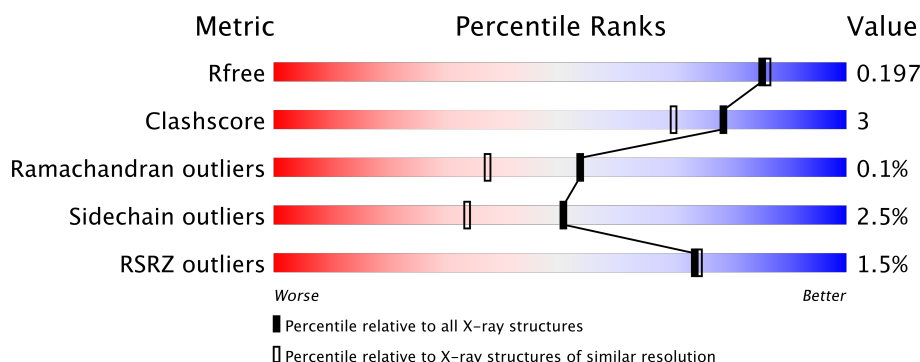
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.85 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}	111664	2111 (1.86-1.86)
Clashscore	122126	2258 (1.86-1.86)
Ramachandran outliers	120053	2234 (1.86-1.86)
Sidechain outliers	120020	2234 (1.86-1.86)
RSRZ outliers	108989	2075 (1.86-1.86)

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 on 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	867	<div> <div style="width: 100%; height: 10px; position: relative;"> <div style="position: absolute; top: -10px; left: 0; width: 100%; text-align: center;">%</div> <div style="position: absolute; top: 10px; left: 0; width: 100%; text-align: center;">90% 9% .</div> </div> </div>

2 Entry composition [i](#)

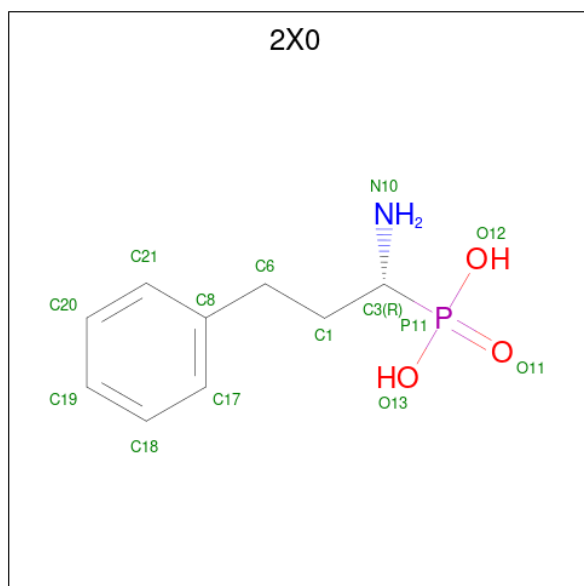
There are 7 unique types of molecules in this entry. The entry contains 7742 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 Aminopeptidase N.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	865	Total	C	N	O	S	Se	0	3	0
			6877	4361	1187	1305	5	19			

- Molecule 2 is [(1R)-1-amino-3-phenylpropyl]phosphonic acid (three-letter code: 2X0) (formula: C₉H₁₄NO₃P).

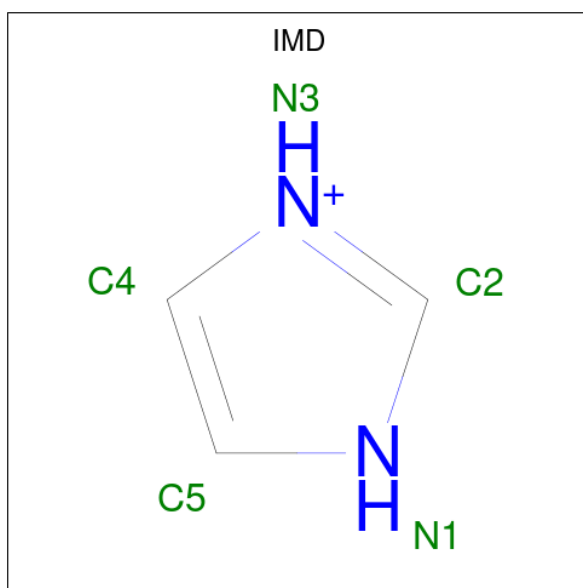


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	1
			14	9	1	3	1		

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn).

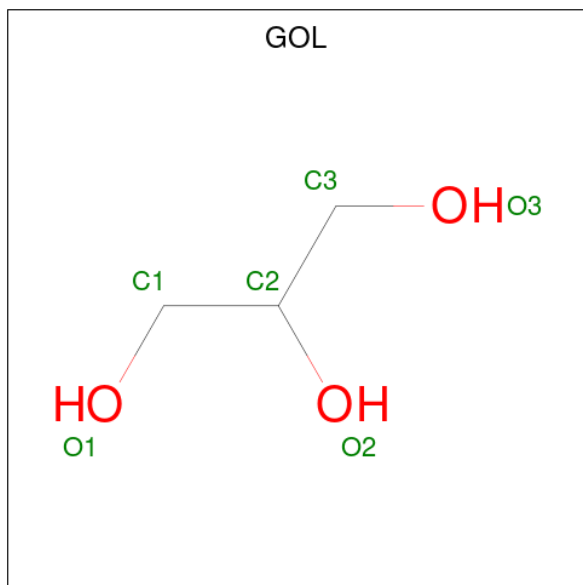
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Zn	0	0
			1	1		

- Molecule 4 is IMIDAZOLE (three-letter code: IMD) (formula: $C_3H_5N_2$).



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

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



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

- Molecule 6 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		
6	A	1	Total	O	S	0	0
			5	4	1		

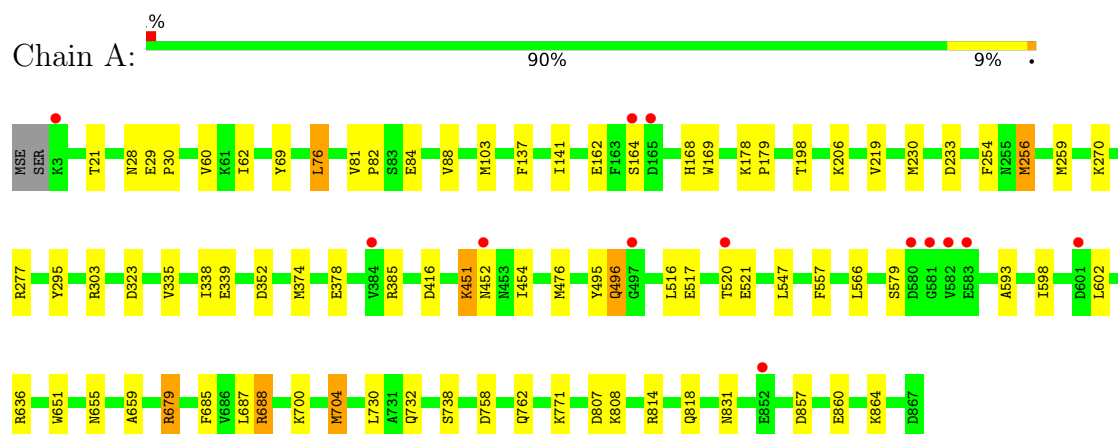
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	794	Total	O	0	0
			794	794		

3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: Aminopeptidase N



4 Data and refinement statistics

Property	Value	Source
Space group	H 3	Depositor
Cell constants a, b, c, α , β , γ	224.05Å 224.05Å 57.81Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	29.86 – 1.85 29.85 – 1.85	Depositor EDS
% Data completeness (in resolution range)	95.0 (29.86-1.85) 95.1 (29.85-1.85)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.82 (at 1.85Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.156 , 0.193 0.163 , 0.197	Depositor DCC
R_{free} test set	4393 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å ²)	20.1	Xtriage
Anisotropy	0.184	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 44.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.021 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	7742	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.15% 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: GOL, ZN, IMD, 2X0, SO4

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	0.97	1/7014 (0.0%)	0.96	13/9482 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	82	PRO	N-CD	5.13	1.55	1.47

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	496	GLN	N-CA-C	-5.89	95.10	111.00
1	A	704	MSE	CA-CB-CG	-5.76	103.51	113.30
1	A	807	ASP	CB-CG-OD1	5.67	123.41	118.30
1	A	636	ARG	NE-CZ-NH2	-5.58	117.51	120.30
1	A	303	ARG	NE-CZ-NH1	5.48	123.04	120.30
1	A	385	ARG	NE-CZ-NH1	5.46	123.03	120.30
1	A	81	VAL	C-N-CD	5.44	139.82	128.40
1	A	688	ARG	NE-CZ-NH2	-5.31	117.65	120.30
1	A	476	MSE	CG-SE-CE	5.30	110.56	98.90
1	A	687	LEU	CA-CB-CG	-5.19	103.37	115.30
1	A	76	LEU	CB-CG-CD1	-5.14	102.26	111.00
1	A	277	ARG	NE-CZ-NH2	-5.07	117.76	120.30
1	A	416	ASP	CB-CG-OD2	5.02	122.82	118.30

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	6877	0	6716	42	0
2	A	14	0	12	3	0
3	A	1	0	0	0	0
4	A	5	0	5	0	0
5	A	6	0	8	1	0
6	A	45	0	0	0	0
7	A	794	0	0	9	0
All	All	7742	0	6741	42	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 3.

All (42) 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:206:LYS:HD3	7:A:1620:HOH:O	1.96	0.66
1:A:69:TYR:CD2	1:A:76:LEU:HD11	2.33	0.63
1:A:28:ASN:ND2	7:A:1750:HOH:O	2.29	0.58
1:A:655:ASN:OD1	1:A:679:ARG:HG3	2.04	0.58
1:A:256[A]:MSE:HE2	2:A:901[A]:2X0:C18	2.35	0.57
1:A:685:PHE:O	1:A:688:ARG:HB2	2.08	0.54
1:A:454:ILE:HD12	1:A:517:GLU:HG2	1.90	0.53
1:A:256[A]:MSE:HE2	2:A:901[A]:2X0:C17	2.40	0.52
1:A:831:ASN:HB2	7:A:1280:HOH:O	2.08	0.51
1:A:62:ILE:HD13	1:A:88:VAL:HG22	1.91	0.51
1:A:547:LEU:HD22	1:A:593:ALA:HB2	1.94	0.49
1:A:198:THR:H	5:A:904:GOL:C1	2.26	0.49
1:A:860:GLU:O	1:A:864:LYS:HG2	2.14	0.48
1:A:254:PHE:CE2	1:A:256[B]:MSE:SE	3.17	0.48
1:A:814:ARG:NH1	7:A:1743:HOH:O	2.36	0.47
1:A:547:LEU:HD23	1:A:566:LEU:HD11	1.95	0.47
1:A:206:LYS:CD	7:A:1620:HOH:O	2.59	0.47
1:A:374:MSE:CE	1:A:378:GLU:HG3	2.46	0.46
1:A:700:LYS:HG3	1:A:704:MSE:HE2	1.98	0.45
1:A:230:MSE:HG2	1:A:295:TYR:CZ	2.52	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:451:LYS:O	1:A:452:ASN:HB2	2.17	0.45
1:A:21:THR:O	1:A:137:PHE:HA	2.17	0.45
1:A:374:MSE:HE1	1:A:378:GLU:HG3	1.99	0.45
1:A:206:LYS:HD2	7:A:1288:HOH:O	2.17	0.44
1:A:730:LEU:HD23	1:A:730:LEU:HA	1.73	0.44
1:A:103:MSE:SE	1:A:818:GLN:OE1	2.87	0.43
1:A:162:GLU:OE1	7:A:1757:HOH:O	2.21	0.43
1:A:598:ILE:HD11	1:A:651:TRP:CH2	2.54	0.43
1:A:732:GLN:NE2	7:A:1783:HOH:O	2.48	0.42
1:A:141:ILE:O	1:A:169:TRP:HA	2.19	0.42
1:A:270:LYS:HE2	7:A:1193:HOH:O	2.20	0.42
1:A:29:GLU:HA	1:A:30:PRO:HA	1.78	0.41
1:A:659:ALA:HB2	1:A:679:ARG:CZ	2.50	0.41
1:A:738:SER:O	1:A:771:LYS:HE3	2.19	0.41
1:A:338:ILE:HD11	1:A:557:PHE:HA	2.03	0.41
1:A:178:LYS:HB2	1:A:179:PRO:HD2	2.01	0.41
1:A:758:ASP:O	1:A:762:GLN:HG3	2.21	0.41
1:A:374:MSE:HB3	1:A:374:MSE:HE3	1.83	0.41
1:A:335:VAL:O	1:A:339:GLU:HG3	2.19	0.40
1:A:259:MSE:SE	2:A:901[A]:2X0:H1	2.70	0.40
1:A:338:ILE:CD1	1:A:557:PHE:HA	2.52	0.40
1:A:808:LYS:HD3	1:A:808:LYS:HA	1.95	0.40

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	866/867 (100%)	844 (98%)	21 (2%)	1 (0%)	53 37

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	495	TYR

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	729/715 (102%)	710 (97%)	19 (3%)	49 32

All (19) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	60	VAL
1	A	84	GLU
1	A	164	SER
1	A	168	HIS
1	A	219	VAL
1	A	233	ASP
1	A	256[A]	MSE
1	A	256[B]	MSE
1	A	323	ASP
1	A	352	ASP
1	A	451	LYS
1	A	496	GLN
1	A	516	LEU
1	A	520	THR
1	A	521	GLU
1	A	579	SER
1	A	602	LEU
1	A	679	ARG
1	A	857	ASP

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

Mol	Chain	Res	Type
1	A	732	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 carbohydrates in this entry.

5.6 Ligand geometry ⓘ

Of 13 ligands modelled in this entry, 1 is monoatomic - leaving 12 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	$\# Z > 2$
6	SO4	A	908	-	4,4,4	0.42	0	6,6,6	0.72	0
6	SO4	A	911	-	4,4,4	0.29	0	6,6,6	0.23	0
6	SO4	A	907	-	4,4,4	0.85	0	6,6,6	0.47	0
2	2X0	A	901[A]	3	13,14,14	3.76	3 (23%)	13,19,19	1.33	2 (15%)
6	SO4	A	910	-	4,4,4	0.40	0	6,6,6	0.17	0
6	SO4	A	905	-	4,4,4	0.50	0	6,6,6	0.49	0
4	IMD	A	903	-	3,5,5	1.22	0	4,5,5	0.73	0
6	SO4	A	909	-	4,4,4	0.55	0	6,6,6	0.82	0
6	SO4	A	913	-	4,4,4	0.59	0	6,6,6	0.40	0
6	SO4	A	912	-	4,4,4	0.35	0	6,6,6	0.37	0
5	GOL	A	904	-	5,5,5	0.71	0	5,5,5	1.72	1 (20%)
6	SO4	A	906	-	4,4,4	0.51	0	6,6,6	0.70	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
5	GOL	A	904	-	-	3/4/4/4	-
4	IMD	A	903	-	-	-	0/1/1/1
2	2X0	A	901[A]	3	-	3/10/11/11	0/1/1/1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	901[A]	2X0	P11-O12	-10.41	1.38	1.54
2	A	901[A]	2X0	P11-O13	-6.37	1.44	1.54
2	A	901[A]	2X0	C6-C8	-4.45	1.38	1.51

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	904	GOL	O2-C2-C3	3.26	123.47	109.12
2	A	901[A]	2X0	O11-P11-C3	-3.02	103.15	113.03
2	A	901[A]	2X0	O12-P11-O11	2.78	120.44	113.45

There are no chirality outliers.

All (6) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	904	GOL	C1-C2-C3-O3
5	A	904	GOL	O2-C2-C3-O3
2	A	901[A]	2X0	C3-C1-C6-C8
2	A	901[A]	2X0	C1-C3-P11-O11
5	A	904	GOL	O1-C1-C2-C3
2	A	901[A]	2X0	N10-C3-P11-O12

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	904	GOL	1	0
2	A	901[A]	2X0	3	0

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

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	847/867 (97%)	-0.36	13 (1%) 73 74	13, 22, 43, 69	0

All (13) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	520	THR	4.8
1	A	3	LYS	4.4
1	A	497	GLY	3.9
1	A	164	SER	3.6
1	A	452	ASN	3.5
1	A	582	VAL	3.4
1	A	852	GLU	3.1
1	A	581	GLY	3.1
1	A	165	ASP	2.8
1	A	601	ASP	2.4
1	A	583	GLU	2.3
1	A	384	VAL	2.2
1	A	580	ASP	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 carbohydrates 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(\AA^2)	Q<0.9
4	IMD	A	903	5/5	0.81	0.16	24,27,31,33	0
6	SO4	A	911	5/5	0.88	0.23	74,78,78,89	0
6	SO4	A	910	5/5	0.92	0.16	65,69,73,74	0
6	SO4	A	905	5/5	0.94	0.16	53,56,61,75	0
6	SO4	A	913	5/5	0.94	0.23	42,45,57,59	0
5	GOL	A	904	6/6	0.94	0.15	28,33,35,42	0
6	SO4	A	908	5/5	0.95	0.26	51,51,53,59	0
6	SO4	A	906	5/5	0.95	0.15	33,38,40,43	5
2	2X0	A	901[A]	14/14	0.96	0.15	13,16,31,34	14
6	SO4	A	909	5/5	0.97	0.08	38,43,47,52	0
6	SO4	A	912	5/5	0.98	0.09	48,49,56,59	0
6	SO4	A	907	5/5	0.99	0.06	20,23,24,24	0
3	ZN	A	902	1/1	1.00	0.04	21,21,21,21	1

6.5 Other polymers [i](#)

There are no such residues in this entry.