



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 03:13 PM UTC

PDB ID : 3CEP / pdb_00003cep
Title : Structure of a tryptophan synthase quinonoid intermediate
Authors : Barends, T.R.M.; Domratcheva, T.; Kulik, V.; Blumenstein, L.; Dunn, M.F.; Schlichting, I.
Deposited on : 2008-02-29
Resolution : 2.10 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

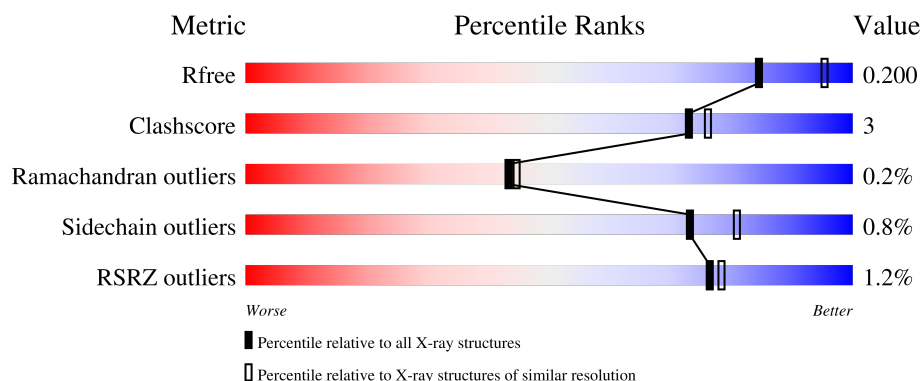
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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	6658 (2.10-2.10)
Clashscore	190562	7164 (2.10-2.10)
Ramachandran outliers	187476	7099 (2.10-2.10)
Sidechain outliers	187428	7100 (2.10-2.10)
RSRZ outliers	180081	6662 (2.10-2.10)

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	268	3% 91% 7% ..
2	B	396	91% 8% .

2 Entry composition [i](#)

There are 8 unique types of molecules in this entry. The entry contains 5266 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 Tryptophan synthase alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	266	Total	C	N	O	S	0	0	0
			1969	1251	340	371	7			

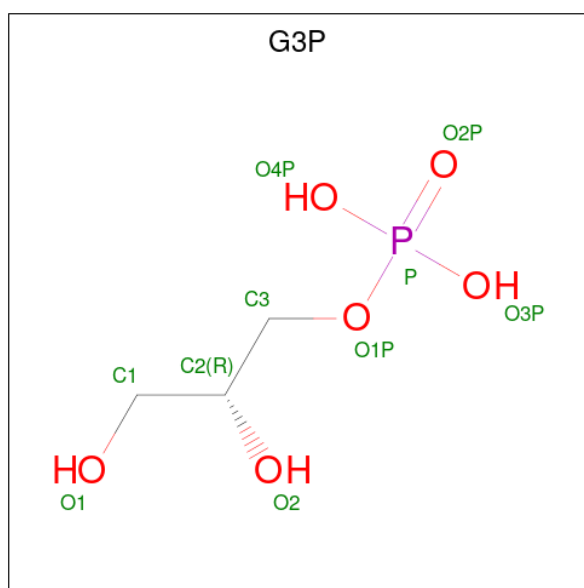
There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	87	ILE	LEU	SEE REMARK 999	UNP P00929

- Molecule 2 is a protein called Tryptophan synthase beta chain.

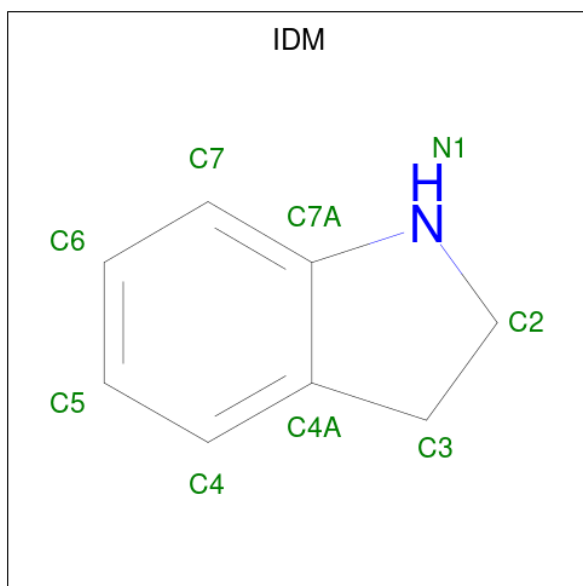
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	393	Total	C	N	O	S	0	0	0
			2967	1862	522	564	19			

- Molecule 3 is SN-GLYCEROL-3-PHOSPHATE (CCD ID: G3P) (formula: C₃H₉O₆P).



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

- Molecule 4 is INDOLINE (CCD ID: IDM) (formula: C₈H₉N).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	N	0	0
			9	8	1		
4	B	1	Total	C	N	0	0
			9	8	1		

- Molecule 5 is CESIUM ION (CCD ID: CS) (formula: Cs).

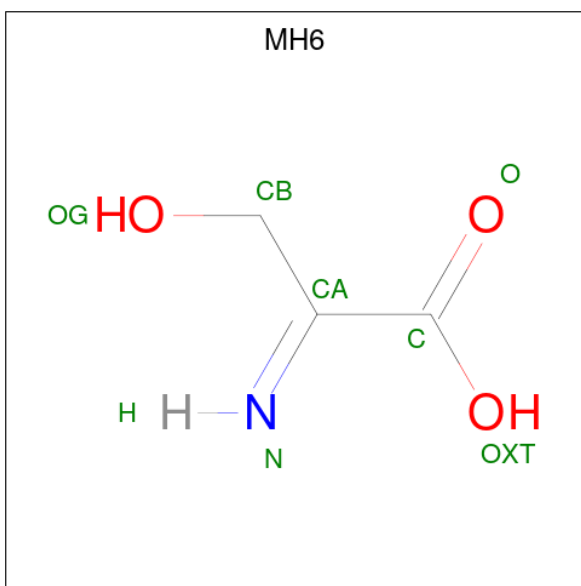
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	3	Total	Cs	0	0
			3	3		

- Molecule 6 is PYRIDOXAL-5'-PHOSPHATE (CCD ID: PLP) (formula: C₈H₁₀NO₆P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
6	B	1	Total	C	N	O	P	0	0
			15	8	1	5	1		

- Molecule 7 is 3-hydroxy-2-iminopropanoic acid (CCD ID: MH6) (formula: $C_3H_5NO_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
7	B	1	Total	C	N	O	0	0
			6	3	1	2		

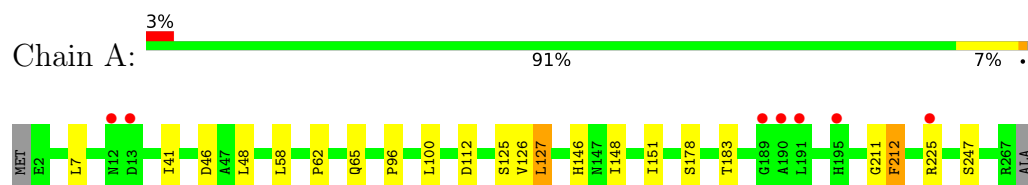
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	100	Total 100	O 100	0	0
8	B	178	Total 178	O 178	0	0

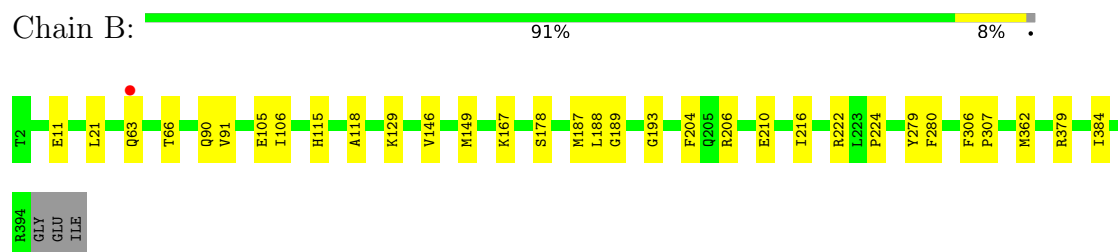
3 Residue-property plots [i](#)

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: Tryptophan synthase alpha chain



- Molecule 2: Tryptophan synthase beta chain



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	184.02Å 58.91Å 67.09Å 90.00° 95.19° 90.00°	Depositor
Resolution (Å)	23.70 – 2.10 23.70 – 2.10	Depositor EDS
% Data completeness (in resolution range)	100.0 (23.70-2.10) 97.9 (23.70-2.10)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.70 (at 2.10Å)	Xtriage
Refinement program	REFMAC 5.2.0005	Depositor
R, R_{free}	0.198 , 0.238 0.202 , 0.200	Depositor DCC
R_{free} test set	2072 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	18.0	Xtriage
Anisotropy	0.891	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 38.5	EDS
L-test for twinning ²	$\langle L \rangle = 0.45$, $\langle L^2 \rangle = 0.28$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	5266	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 5.20% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: CS, IDM, G3P, PLP, MH6

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	0.50	0/2008	0.84	2/2735 (0.1%)
2	B	0.52	0/3024	0.83	0/4087
All	All	0.51	0/5032	0.83	2/6822 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	247	SER	CA-C-N	5.30	124.94	119.05
1	A	247	SER	C-N-CA	5.30	124.94	119.05

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

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	1969	0	1945	12	0
2	B	2967	0	2938	18	0
3	A	10	0	4	3	0
4	A	9	0	8	2	0
4	B	9	0	8	0	0
5	B	3	0	0	0	0
6	B	15	0	6	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	B	6	0	0	0	0
8	A	100	0	0	0	0
8	B	178	0	0	3	0
All	All	5266	0	4909	32	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 (32) 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)
3:A:269:G3P:O2	4:A:270:IDM:H22	1.83	0.78
2:B:206:ARG:HD3	2:B:210:GLU:OE2	1.91	0.70
1:A:211:GLY:O	1:A:212:PHE:HB2	1.97	0.63
1:A:183:THR:HG22	3:A:269:G3P:H32	1.86	0.58
2:B:21:LEU:HD21	2:B:178:SER:HA	1.86	0.56
2:B:222:ARG:NH2	8:B:520:HOH:O	2.40	0.55
2:B:115:HIS:CE1	2:B:189:GLY:HA2	2.42	0.55
2:B:167:LYS:HD3	2:B:307:PRO:HG3	1.90	0.54
1:A:41:ILE:HD11	1:A:48:LEU:HD11	1.91	0.53
3:A:269:G3P:O2	4:A:270:IDM:C2	2.57	0.52
1:A:100:LEU:HD23	1:A:127:LEU:HD13	1.92	0.51
1:A:125:SER:HB2	1:A:151:ILE:HD11	1.94	0.49
2:B:216:ILE:HG21	2:B:224:PRO:HD3	1.93	0.49
1:A:58:LEU:H	1:A:58:LEU:HD23	1.78	0.48
1:A:178:SER:OG	1:A:212:PHE:O	2.32	0.47
1:A:126:VAL:HG23	1:A:148:ILE:HG21	1.97	0.46
2:B:63:GLN:HB2	8:B:445:HOH:O	2.15	0.46
2:B:106:ILE:HD12	2:B:187:MET:HE3	1.96	0.46
2:B:379:ARG:NH1	8:B:528:HOH:O	2.49	0.46
2:B:11:GLU:HG2	2:B:11:GLU:O	2.15	0.46
2:B:193:GLY:HA2	2:B:280:PHE:O	2.16	0.45
2:B:91:VAL:HG21	2:B:118:ALA:HB1	1.99	0.44
2:B:146:VAL:HA	2:B:149:MET:HE3	2.01	0.43
2:B:306:PHE:CD1	2:B:307:PRO:HD2	2.54	0.43
1:A:7:LEU:HD11	1:A:46:ASP:HB3	2.01	0.42
2:B:66:THR:HA	2:B:362:MET:SD	2.60	0.41
2:B:167:LYS:HG3	2:B:279:TYR:OH	2.19	0.41
1:A:7:LEU:HD22	1:A:96:PRO:HG2	2.02	0.41
1:A:62:PRO:HA	1:A:65:GLN:HB2	2.02	0.41
1:A:112:ASP:OD1	1:A:146:HIS:HE1	2.04	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:90:GLN:HA	2:B:204:PHE:HB3	2.03	0.41
2:B:105:GLU:HG2	2:B:129:LYS:HB3	2.02	0.41

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	264/268 (98%)	259 (98%)	4 (2%)	1 (0%)	30	28
2	B	391/396 (99%)	383 (98%)	8 (2%)	0	100	100
All	All	655/664 (99%)	642 (98%)	12 (2%)	1 (0%)	43	44

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	212	PHE

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	199/208 (96%)	197 (99%)	2 (1%)	68	76
2	B	306/310 (99%)	304 (99%)	2 (1%)	76	83
All	All	505/518 (98%)	501 (99%)	4 (1%)	73	81

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	127	LEU
1	A	225	ARG
2	B	188	LEU
2	B	384	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	12	ASN
1	A	120	GLN
1	A	165	GLN
1	A	195	HIS
2	B	365	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 8 ligands modelled in this entry, 3 are monoatomic - leaving 5 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
3	G3P	A	269	4	9,9,9	1.63	2 (22%)	10,12,12	1.16	1 (10%)
6	PLP	B	401	7	15,15,16	3.00	6 (40%)	21,22,23	1.68	3 (14%)
4	IDM	A	270	3	9,10,10	1.18	0	9,13,13	1.95	3 (33%)
4	IDM	B	403	7	9,10,10	1.29	2 (22%)	9,13,13	2.26	3 (33%)
7	MH6	B	402	4,6	4,5,6	1.62	2 (50%)	4,6,7	3.42	3 (75%)

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
3	G3P	A	269	4	-	6/8/8/8	-
6	PLP	B	401	7	-	0/6/6/8	0/1/1/1
4	IDM	A	270	3	-	-	0/2/2/2
4	IDM	B	403	7	-	-	0/2/2/2
7	MH6	B	402	4,6	-	0/2/4/6	-

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	B	401	PLP	C4A-C4	-5.63	1.40	1.51
6	B	401	PLP	P-O4P	-5.58	1.42	1.60
6	B	401	PLP	C3-C4	4.93	1.49	1.40
6	B	401	PLP	C5-C4	4.30	1.45	1.40
6	B	401	PLP	O3-C3	-3.97	1.27	1.36
3	A	269	G3P	O2-C2	-3.62	1.32	1.43
6	B	401	PLP	C2-N1	2.87	1.39	1.33
7	B	402	MH6	CA-N	2.27	1.31	1.27
3	A	269	G3P	O1-C1	-2.21	1.33	1.42
4	B	403	IDM	C5-C4	2.16	1.42	1.38
7	B	402	MH6	OXT-C	-2.06	1.25	1.30
4	B	403	IDM	C2-N1	2.06	1.50	1.46

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
7	B	402	MH6	O-C-CA	-5.53	114.59	121.35
6	B	401	PLP	O4P-C5A-C5	5.30	119.30	109.36
4	B	403	IDM	C4-C4A-C7A	5.04	122.20	119.67
4	A	270	IDM	C4-C4A-C7A	4.08	121.72	119.67

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	403	IDM	C2-C3-C4A	-3.19	100.44	103.67
7	B	402	MH6	CB-CA-C	3.06	121.00	118.11
4	A	270	IDM	C2-C3-C4A	-2.91	100.73	103.67
7	B	402	MH6	OXT-C-O	2.57	130.01	123.90
3	A	269	G3P	O3P-P-O1P	-2.28	100.73	106.67
6	B	401	PLP	C4-C3-C2	-2.26	116.51	119.89
4	A	270	IDM	C5-C4-C4A	-2.23	117.61	120.88
6	B	401	PLP	C6-N1-C2	2.22	123.23	119.20
4	B	403	IDM	C5-C4-C4A	-2.15	117.73	120.88

There are no chirality outliers.

All (6) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	269	G3P	C1-C2-C3-O1P
3	A	269	G3P	O2-C2-C3-O1P
3	A	269	G3P	O1-C1-C2-O2
3	A	269	G3P	O1-C1-C2-C3
3	A	269	G3P	C2-C3-O1P-P
3	A	269	G3P	C3-O1P-P-O3P

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	269	G3P	3	0
4	A	270	IDM	2	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	266/268 (99%)	0.24	7 (2%) 57 60	16, 26, 41, 48	1 (0%)
2	B	393/396 (99%)	-0.25	1 (0%) 90 91	11, 17, 26, 46	0
All	All	659/664 (99%)	-0.05	8 (1%) 76 78	11, 20, 37, 48	1 (0%)

All (8) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	190	ALA	3.6
1	A	13	ASP	2.8
1	A	195	HIS	2.6
2	B	63	GLN	2.3
1	A	189	GLY	2.2
1	A	191	LEU	2.1
1	A	225	ARG	2.1
1	A	12	ASN	2.0

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
4	IDM	B	403	9/9	0.92	0.13	21,22,23,23	0
4	IDM	A	270	9/9	0.94	0.07	19,19,20,20	0
7	MH6	B	402	6/7	0.94	0.09	18,18,18,19	0
6	PLP	B	401	15/16	0.97	0.06	12,14,17,17	0
3	G3P	A	269	10/10	0.97	0.06	21,23,25,25	0
5	CS	B	400	1/1	1.00	0.05	34,34,34,34	0
5	CS	B	398	1/1	1.00	0.01	19,19,19,19	0
5	CS	B	399	1/1	1.00	0.04	35,35,35,35	1

6.5 Other polymers ⓘ

There are no such residues in this entry.