



wwPDB X-ray Structure Validation Summary Report ⓘ

Sep 18, 2023 – 02:39 PM EDT

PDB ID : 3PCJ
Title : STRUCTURE OF PROTOCATECHUATE 3,4-DIOXYGENASE COM-
PLEXED WITH 2-HYDROXYISONICOTINIC ACID N-OXIDE
Authors : Orville, A.M.; Lipscomb, J.D.; Ohlendorf, D.H.
Deposited on : 1997-07-18
Resolution : 2.13 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 : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtrriage (Phenix) : **NOT EXECUTED**
EDS : **NOT EXECUTED**
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.35.1

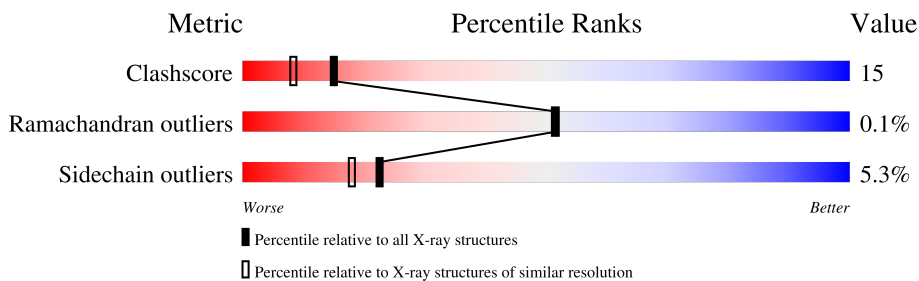
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.13 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	141614	2653 (2.16-2.12)
Ramachandran outliers	138981	2618 (2.16-2.12)
Sidechain outliers	138945	2617 (2.16-2.12)





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 $\leq 5\%$

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	200	
1	B	200	
1	C	200	
1	D	200	
1	E	200	
1	F	200	
2	M	238	
2	N	238	

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Mol	Chain	Length	Quality of chain
2	O	238	 66% 25% 6% .
2	P	238	 68% 24% 5% ..
2	Q	238	 67% 26% 5% .
2	R	238	 62% 29% 6% ..

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 21978 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 PROTOCATECHUATE 3,4-DIOXYGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	200	1571	993	276	299	3	0	0	0
1	B	200	1571	993	276	299	3	0	0	0
1	C	200	1571	993	276	299	3	0	0	0
1	D	200	1571	993	276	299	3	0	0	0
1	E	200	1571	993	276	299	3	0	0	0
1	F	200	1571	993	276	299	3	0	0	0

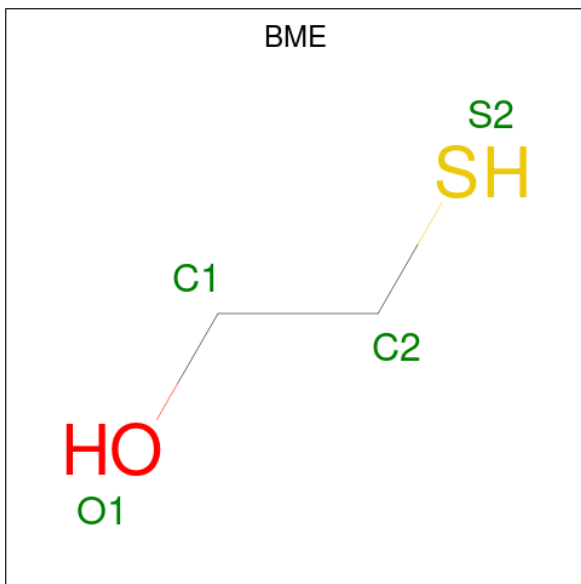
- Molecule 2 is a protein called PROTOCATECHUATE 3,4-DIOXYGENASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	M	233	1840	1171	334	328	7	0	0	0
2	N	233	1840	1171	334	328	7	0	0	0
2	O	233	1840	1171	334	328	7	0	0	0
2	P	233	1840	1171	334	328	7	0	0	0
2	Q	233	1840	1171	334	328	7	0	0	0
2	R	233	1840	1171	334	328	7	0	0	0

- Molecule 3 is FE (III) ION (three-letter code: FE) (formula: Fe).

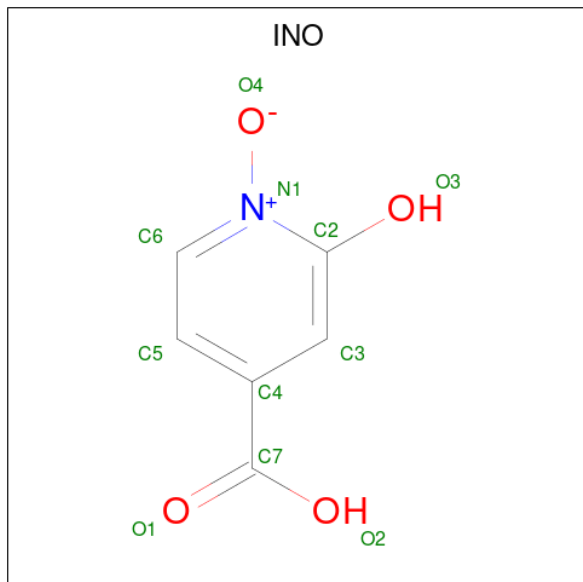
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	M	1	Total Fe 1 1	0	0
3	N	1	Total Fe 1 1	0	0
3	O	1	Total Fe 1 1	0	0
3	P	1	Total Fe 1 1	0	0
3	Q	1	Total Fe 1 1	0	0
3	R	1	Total Fe 1 1	0	0

- Molecule 4 is BETA-MERCAPTOETHANOL (three-letter code: BME) (formula: C₂H₆OS).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	M	1	Total C O S 4 2 1 1	0	0
4	N	1	Total C O S 4 2 1 1	0	0
4	O	1	Total C O S 4 2 1 1	0	0
4	P	1	Total C O S 4 2 1 1	0	0
4	Q	1	Total C O S 4 2 1 1	0	0
4	R	1	Total C O S 4 2 1 1	0	0

- Molecule 5 is 2-HYDROXYISONICOTINIC ACID N-OXIDE (three-letter code: INO) (formula: C₆H₅NO₄).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
5	M	1	Total 11	C 6	N 1	O 4	0	0
5	N	1	Total 11	C 6	N 1	O 4	0	0
5	O	1	Total 11	C 6	N 1	O 4	0	0
5	P	1	Total 11	C 6	N 1	O 4	0	0
5	Q	1	Total 11	C 6	N 1	O 4	0	0
5	R	1	Total 11	C 6	N 1	O 4	0	0

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	A	79	Total 79	O 79	0	0
6	M	155	Total 155	O 155	0	0
6	B	78	Total 78	O 78	0	0
6	N	163	Total 163	O 163	0	0

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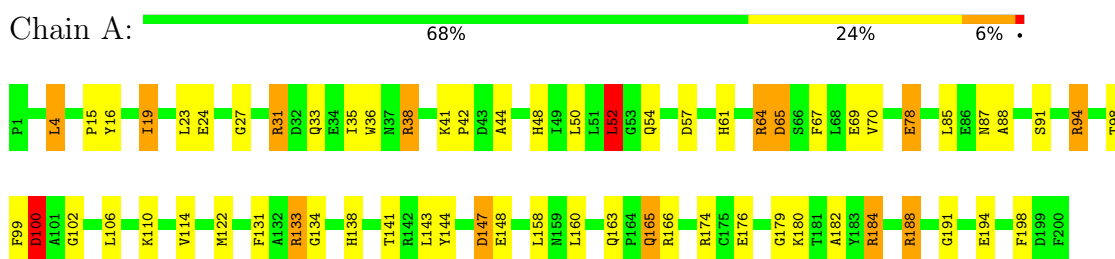
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	C	76	Total 76	O 76	0	0
6	O	158	Total 158	O 158	0	0
6	D	79	Total 79	O 79	0	0
6	P	149	Total 149	O 149	0	0
6	E	81	Total 81	O 81	0	0
6	Q	160	Total 160	O 160	0	0
6	F	75	Total 75	O 75	0	0
6	R	163	Total 163	O 163	0	0

3 Residue-property plots [i](#)

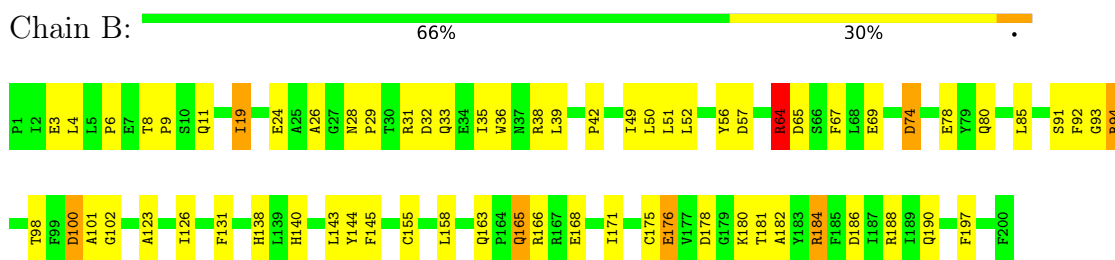
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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. 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.

Note EDS was not executed.

- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE



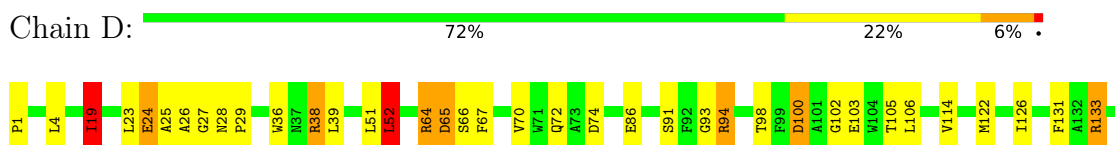
- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE

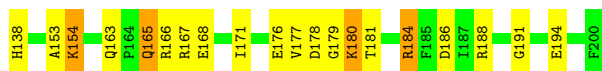


- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE



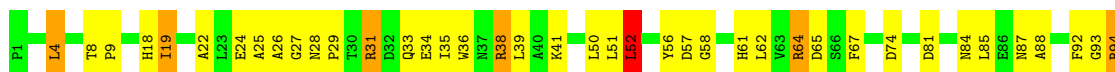
- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE





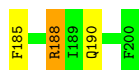
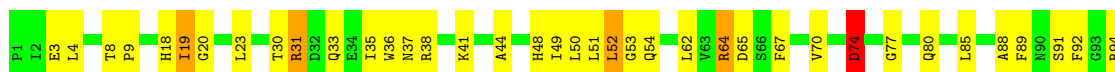
- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE

Chain E: 60% 34% 6%



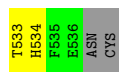
- Molecule 1: PROTOCATECHUATE 3,4-DIOXYGENASE

Chain F: 60% 34% 6%



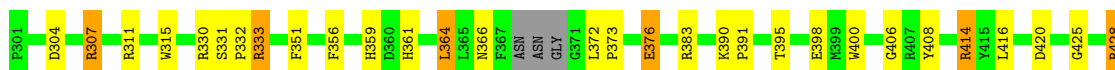
- Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

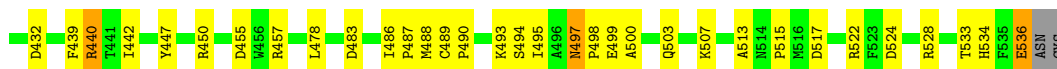
Chain M: 69% 24%



- Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

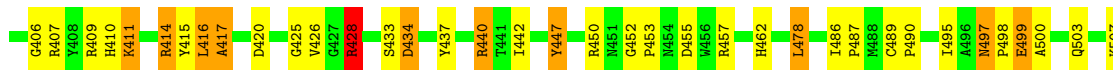
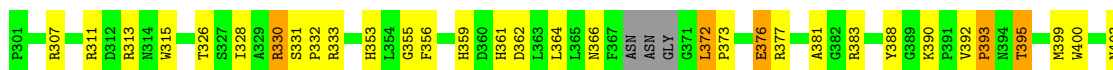
Chain N: 71% 23%





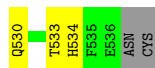
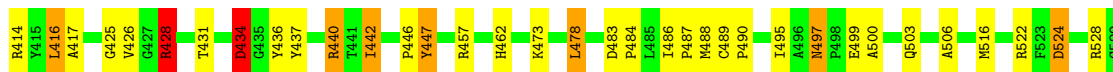
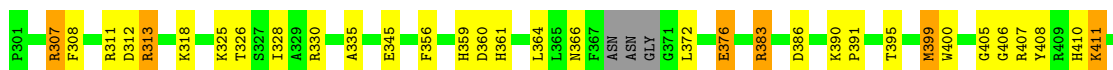
• Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

Chain O: 66% 25% 6%



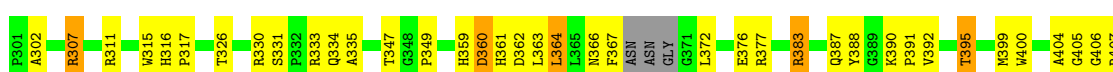
• Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

Chain P: 68% 24% 5%



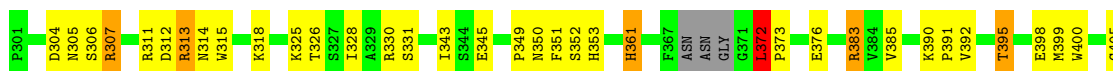
• Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

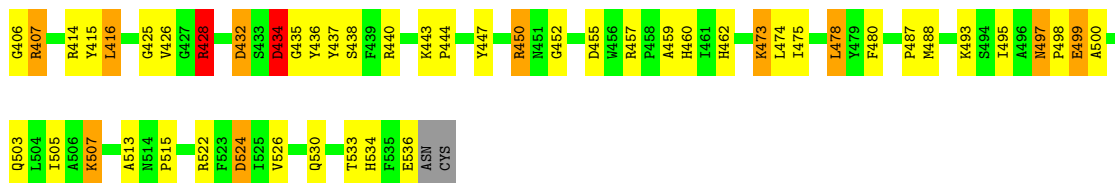
Chain Q: 67% 26% 5%



• Molecule 2: PROTOCATECHUATE 3,4-DIOXYGENASE

Chain R: 62% 29% 6%





4 Data and refinement statistics

Xtrriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	I 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	196.20Å 127.10Å 133.70Å 90.00° 97.70° 90.00°	Depositor
Resolution (Å)	6.00 – 2.13	Depositor
% Data completeness (in resolution range)	96.0 (6.00-2.13)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	0.07	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.173 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	21978	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

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: BME, FE, INO

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	1.00	2/1611 (0.1%)	1.73	31/2195 (1.4%)
1	B	0.99	0/1611	1.73	31/2195 (1.4%)
1	C	0.99	0/1611	1.59	20/2195 (0.9%)
1	D	1.01	0/1611	1.65	29/2195 (1.3%)
1	E	1.02	0/1611	1.63	21/2195 (1.0%)
1	F	1.07	0/1611	1.69	28/2195 (1.3%)
2	M	1.04	0/1895	1.65	19/2580 (0.7%)
2	N	1.05	1/1895 (0.1%)	1.66	32/2580 (1.2%)
2	O	1.04	0/1895	1.66	34/2580 (1.3%)
2	P	1.05	1/1895 (0.1%)	1.61	27/2580 (1.0%)
2	Q	1.07	2/1895 (0.1%)	1.59	20/2580 (0.8%)
2	R	1.08	1/1895 (0.1%)	1.64	32/2580 (1.2%)
All	All	1.04	7/21036 (0.0%)	1.65	324/28650 (1.1%)

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	B	0	1
2	R	0	1
All	All	0	2

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	94	ARG	CD-NE	-6.42	1.35	1.46
2	Q	367	PHE	C-O	5.63	1.34	1.23
2	P	345	GLU	CD-OE1	-5.43	1.19	1.25
2	N	398	GLU	CD-OE1	-5.23	1.20	1.25

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	R	398	GLU	CD-OE1	-5.19	1.20	1.25

The worst 5 of 324 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	N	440	ARG	NE-CZ-NH2	-23.94	108.33	120.30
2	R	440	ARG	NE-CZ-NH2	-22.70	108.95	120.30
2	M	440	ARG	NE-CZ-NH2	-22.15	109.22	120.30
2	P	440	ARG	NE-CZ-NH2	-20.59	110.00	120.30
2	O	440	ARG	NE-CZ-NH2	-19.60	110.50	120.30

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	184	ARG	Sidechain
2	R	407	ARG	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	1571	0	1499	60	0
1	B	1571	0	1499	47	0
1	C	1571	0	1499	61	0
1	D	1571	0	1499	44	0
1	E	1571	0	1499	69	0
1	F	1571	0	1499	74	0
2	M	1840	0	1793	63	0
2	N	1840	0	1793	42	0
2	O	1840	0	1793	54	0
2	P	1840	0	1793	50	0
2	Q	1840	0	1793	58	0
2	R	1840	0	1793	67	0
3	M	1	0	0	0	0
3	N	1	0	0	0	0
3	O	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	P	1	0	0	0	0
3	Q	1	0	0	0	0
3	R	1	0	0	0	0
4	M	4	0	5	0	0
4	N	4	0	5	1	0
4	O	4	0	5	0	0
4	P	4	0	5	0	0
4	Q	4	0	5	0	0
4	R	4	0	5	0	0
5	M	11	0	3	0	0
5	N	11	0	3	0	0
5	O	11	0	3	0	0
5	P	11	0	3	0	0
5	Q	11	0	3	0	0
5	R	11	0	3	0	0
6	A	79	0	0	1	0
6	B	78	0	0	1	0
6	C	76	0	0	2	0
6	D	79	0	0	0	0
6	E	81	0	0	0	0
6	F	75	0	0	1	0
6	M	155	0	0	3	0
6	N	163	0	0	5	0
6	O	158	0	0	6	0
6	P	149	0	0	5	0
6	Q	160	0	0	6	0
6	R	163	0	0	4	0
All	All	21978	0	19800	610	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 15.

The worst 5 of 610 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:B:165:GLN:H	1:B:165:GLN:NE2	1.34	1.22
1:E:165:GLN:H	1:E:165:GLN:NE2	1.36	1.21
1:E:165:GLN:HE21	1:E:165:GLN:N	1.40	1.16
2:R:497:ASN:ND2	2:R:499:GLU:H	1.48	1.11
1:A:134:GLY:CA	2:M:326:THR:HG22	1.88	1.03

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	198/200 (99%)	188 (95%)	10 (5%)	0	100	100
1	B	198/200 (99%)	188 (95%)	10 (5%)	0	100	100
1	C	198/200 (99%)	189 (96%)	8 (4%)	1 (0%)	29	22
1	D	198/200 (99%)	187 (94%)	11 (6%)	0	100	100
1	E	198/200 (99%)	187 (94%)	11 (6%)	0	100	100
1	F	198/200 (99%)	188 (95%)	9 (4%)	1 (0%)	29	22
2	M	229/238 (96%)	219 (96%)	10 (4%)	0	100	100
2	N	229/238 (96%)	221 (96%)	8 (4%)	0	100	100
2	O	229/238 (96%)	222 (97%)	7 (3%)	0	100	100
2	P	229/238 (96%)	224 (98%)	5 (2%)	0	100	100
2	Q	229/238 (96%)	221 (96%)	8 (4%)	0	100	100
2	R	229/238 (96%)	222 (97%)	7 (3%)	0	100	100
All	All	2562/2628 (98%)	2456 (96%)	104 (4%)	2 (0%)	51	51

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	101	ALA
1	F	74	ASP

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	162/163 (99%)	153 (94%)	9 (6%)	21	16
1	B	162/163 (99%)	154 (95%)	8 (5%)	25	20
1	C	162/163 (99%)	155 (96%)	7 (4%)	29	25
1	D	162/163 (99%)	154 (95%)	8 (5%)	25	20
1	E	162/163 (99%)	153 (94%)	9 (6%)	21	16
1	F	162/163 (99%)	155 (96%)	7 (4%)	29	25
2	M	196/202 (97%)	183 (93%)	13 (7%)	16	11
2	N	196/202 (97%)	189 (96%)	7 (4%)	35	32
2	O	196/202 (97%)	184 (94%)	12 (6%)	18	13
2	P	196/202 (97%)	184 (94%)	12 (6%)	18	13
2	Q	196/202 (97%)	186 (95%)	10 (5%)	24	19
2	R	196/202 (97%)	185 (94%)	11 (6%)	21	16
All	All	2148/2190 (98%)	2035 (95%)	113 (5%)	22	18

5 of 113 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	19	ILE
2	R	497	ASN
2	P	442	ILE
2	R	478	LEU
1	F	165	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 33 such sidechains are listed below:

Mol	Chain	Res	Type
2	Q	503	GLN
1	F	165	GLN
2	R	503	GLN
1	C	163	GLN
2	N	534	HIS

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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 18 ligands modelled in this entry, 6 are 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
5	INO	M	550	3	8,11,11	1.81	3 (37%)	10,15,15	1.25	2 (20%)
4	BME	O	601	2	3,3,3	0.53	0	1,2,2	1.03	0
5	INO	R	550	3	8,11,11	1.72	2 (25%)	10,15,15	1.00	1 (10%)
4	BME	Q	601	2	3,3,3	1.02	0	1,2,2	1.46	0
4	BME	P	601	2	3,3,3	0.77	0	1,2,2	2.28	1 (100%)
4	BME	N	601	2	3,3,3	0.61	0	1,2,2	1.55	0
4	BME	M	601	2	3,3,3	0.68	0	1,2,2	1.43	0
4	BME	R	601	2	3,3,3	0.39	0	1,2,2	0.96	0
5	INO	N	550	3	8,11,11	1.67	3 (37%)	10,15,15	1.12	0
5	INO	O	550	3	8,11,11	1.70	3 (37%)	10,15,15	1.13	0
5	INO	Q	550	3	8,11,11	1.76	3 (37%)	10,15,15	1.16	1 (10%)
5	INO	P	550	3	8,11,11	1.67	2 (25%)	10,15,15	1.10	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. '2' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
5	INO	M	550	3	-	0/4/4/4	0/1/1/1

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	BME	O	601	2	-	0/1/1/1	-
5	INO	R	550	3	-	0/4/4/4	0/1/1/1
4	BME	Q	601	2	-	1/1/1/1	-
4	BME	P	601	2	-	0/1/1/1	-
4	BME	N	601	2	-	1/1/1/1	-
4	BME	M	601	2	-	0/1/1/1	-
4	BME	R	601	2	-	1/1/1/1	-
5	INO	N	550	3	-	0/4/4/4	0/1/1/1
5	INO	O	550	3	-	0/4/4/4	0/1/1/1
5	INO	Q	550	3	-	0/4/4/4	0/1/1/1
5	INO	P	550	3	-	0/4/4/4	0/1/1/1

The worst 5 of 16 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	R	550	INO	O3-C2	-3.16	1.23	1.32
5	N	550	INO	O3-C2	-3.01	1.23	1.32
5	Q	550	INO	C3-C4	3.00	1.43	1.39
5	M	550	INO	O3-C2	-2.94	1.24	1.32
5	P	550	INO	O3-C2	-2.85	1.24	1.32

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	M	550	INO	O2-C7-C4	2.65	121.73	114.85
4	P	601	BME	O1-C1-C2	-2.28	101.85	110.83
5	R	550	INO	O2-C7-O1	-2.09	118.72	123.35
5	Q	550	INO	O2-C7-C4	2.06	120.20	114.85
5	M	550	INO	O2-C7-O1	-2.05	118.80	123.35

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	N	601	BME	O1-C1-C2-S2
4	Q	601	BME	O1-C1-C2-S2
4	R	601	BME	O1-C1-C2-S2

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	N	601	BME	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](#)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.