



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 07:54 AM UTC

PDB ID : 4WHS / pdb_00004whs
Title : 4-fluorocatechol bound to Protocatechuate 3,4-dioxygenase (pseudomonas putida) at pH 8.5
Authors : Knoot, C.J.; Purpero, V.M.; Lipscomb, J.D.
Deposited on : 2014-09-23
Resolution : 1.35 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

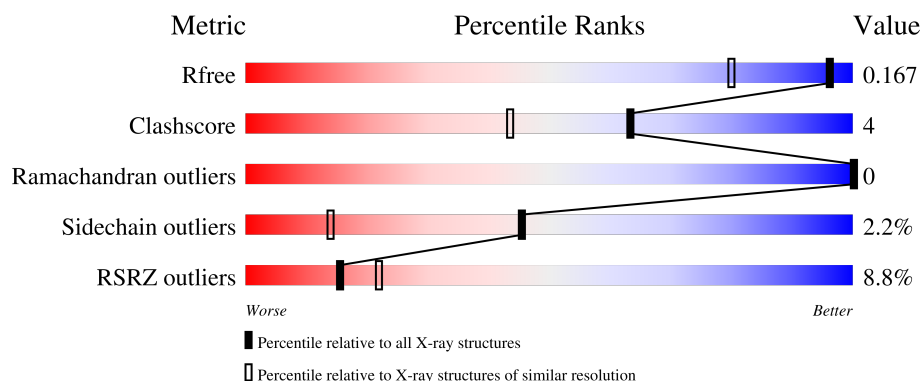
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.35 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	1216 (1.36-1.36)
Clashscore	190562	1232 (1.36-1.36)
Ramachandran outliers	187476	1220 (1.36-1.36)
Sidechain outliers	187428	1220 (1.36-1.36)
RSRZ outliers	180081	1214 (1.36-1.36)

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	200	9% 95% 5%
1	C	200	7% 92% 8%
1	E	200	16% 92% 6%
2	B	238	6% 91% 8%
2	F	238	8% 92% 7%

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Mol	Chain	Length	Quality of chain
3	D	238	8% 91% 8%

2 Entry composition

There are 10 unique types of molecules in this entry. The entry contains 12126 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 alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	200	Total	C	N	O	S	0	5	0
			1614	1022	284	305	3			
1	E	200	Total	C	N	O	S	0	5	0
			1618	1023	287	305	3			
1	C	200	Total	C	N	O	S	0	5	0
			1612	1022	282	305	3			

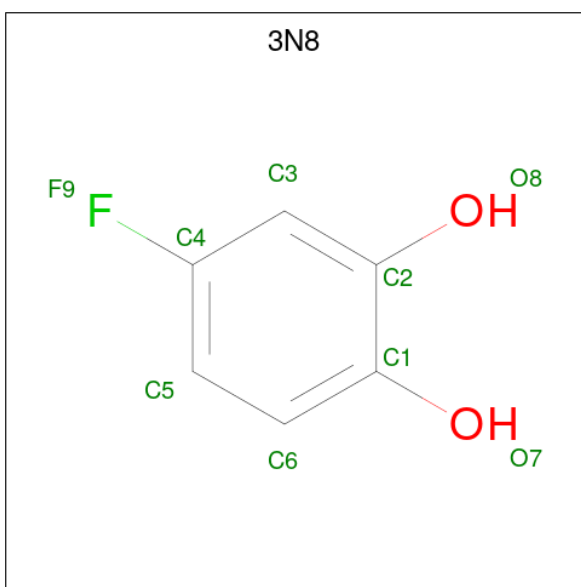
- Molecule 2 is a protein called Protocatechuate 3,4-dioxygenase beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	F	238	Total	C	N	O	S	0	6	0
			1928	1223	350	346	9			
2	B	238	Total	C	N	O	S	0	8	0
			1944	1234	353	348	9			

- Molecule 3 is a protein called Protocatechuate 3,4-dioxygenase beta chain.

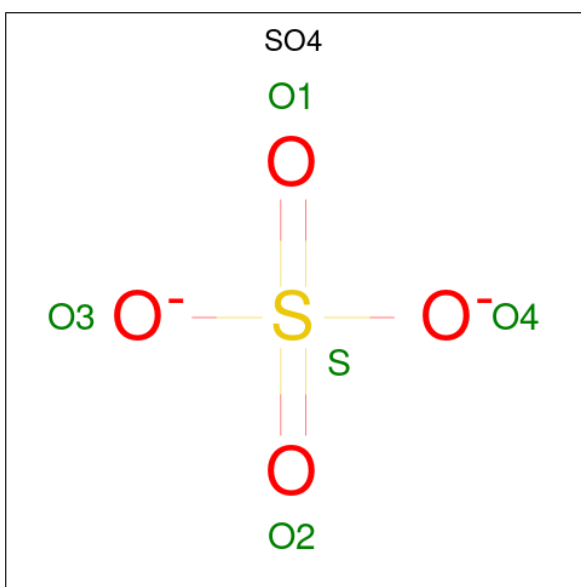
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	238	Total	C	N	O	S	0	7	0
			1941	1232	352	348	9			

- Molecule 4 is 4-fluorobenzene-1,2-diol (CCD ID: 3N8) (formula: C₆H₅FO₂).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	F	O	0	0
			9	6	1	2		
4	F	1	Total	C	F	O	0	0
			9	6	1	2		
4	F	1	Total	C	F	O	0	0
			9	6	1	2		
4	F	1	Total	C	F	O	0	1
			18	12	2	4		
4	E	1	Total	C	F	O	0	0
			9	6	1	2		
4	C	1	Total	C	F	O	0	0
			9	6	1	2		
4	D	1	Total	C	F	O	0	1
			18	12	2	4		
4	D	1	Total	C	F	O	0	0
			9	6	1	2		
4	B	1	Total	C	F	O	0	1
			18	12	2	4		
4	B	1	Total	C	F	O	0	0
			9	6	1	2		

- Molecule 5 is SULFATE ION (CCD ID: SO4) (formula: O₄S).

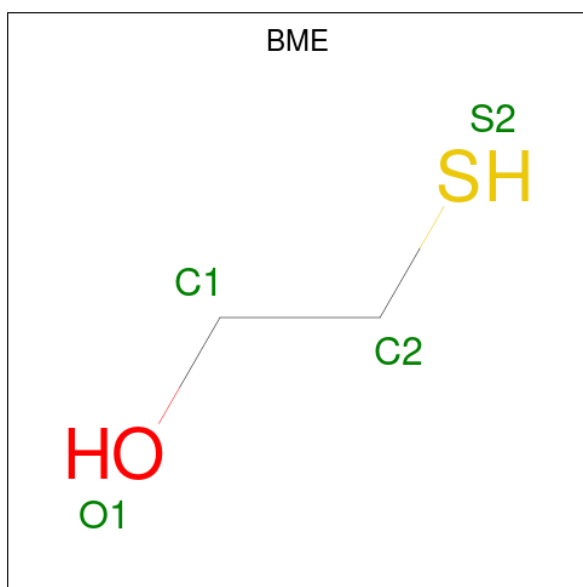


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	O	S	0	0
			5	4	1		

- Molecule 6 is FE (III) ION (CCD ID: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	F	1	Total	Fe	0	0
			1	1		
6	D	1	Total	Fe	0	0
			1	1		
6	B	1	Total	Fe	0	0
			1	1		

- Molecule 7 is BETA-MERCAPTOETHANOL (CCD ID: BME) (formula: C₂H₆OS).

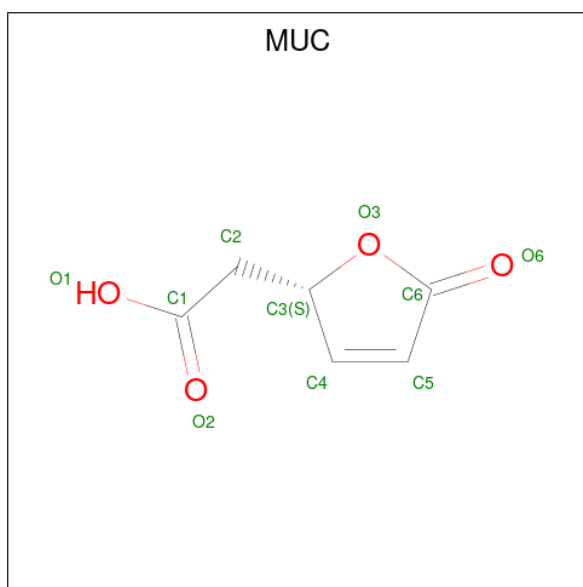


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
7	F	1	Total	C	O	S	0	0
			4	2	1	1		
7	C	1	Total	C	O	S	0	0
			4	2	1	1		
7	C	1	Total	C	O	S	0	0
			4	2	1	1		
7	B	1	Total	C	O	S	0	0
			4	2	1	1		

- Molecule 8 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	F	1	Total	Cl	0	0
			1	1		
8	B	2	Total	Cl	0	0
			2	2		

- Molecule 9 is [(2S)-5-oxo-2,5-dihydrofuran-2-yl]acetic acid (CCD ID: MUC) (formula: C₆H₆O₄).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
9	E	1	Total	C	O	0	0
			10	6	4		
9	C	1	Total	C	O	0	0
			10	6	4		

- Molecule 10 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	A	184	Total	O	0	2
			186	186		
10	F	243	Total	O	0	3
			246	246		
10	E	153	Total	O	0	2
			155	155		
10	C	198	Total	O	0	2
			200	200		
10	D	255	Total	O	0	0
			255	255		
10	B	261	Total	O	0	2
			263	263		

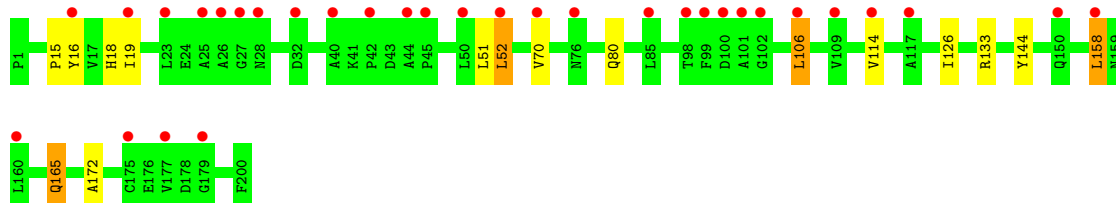
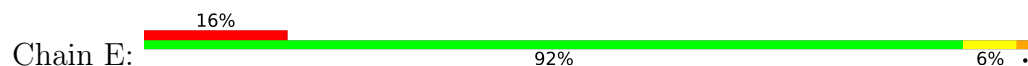
3 Residue-property plots [i](#)

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.

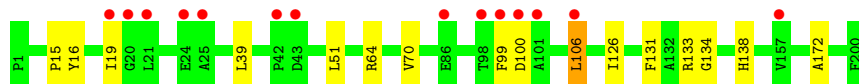
- Molecule 1: Protocatechuate 3,4-dioxygenase alpha chain



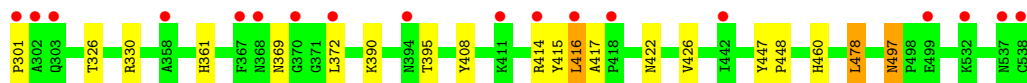
- Molecule 1: Protocatechuate 3,4-dioxygenase alpha chain



- Molecule 1: Protocatechuate 3,4-dioxygenase alpha chain

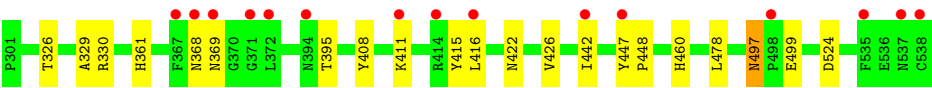


- Molecule 2: Protocatechuate 3,4-dioxygenase beta chain

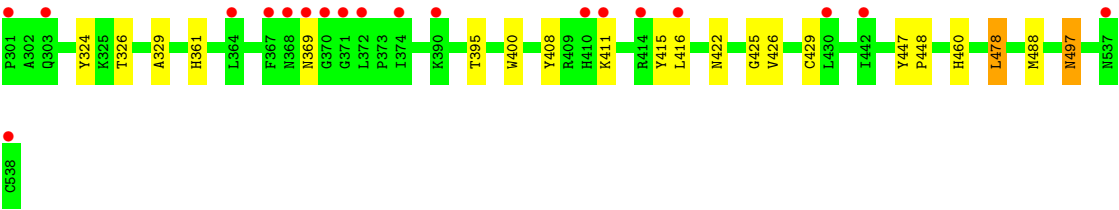
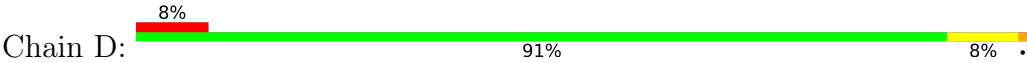


- Molecule 2: Protocatechuate 3,4-dioxygenase beta chain





● Molecule 3: Protocatechuate 3,4-dioxygenase beta chain



4 Data and refinement statistics

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α , β , γ	128.01Å 140.66Å 168.14Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	29.55 – 1.35 29.55 – 1.35	Depositor EDS
% Data completeness (in resolution range)	94.5 (29.55-1.35) 94.5 (29.55-1.35)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.99 (at 1.35Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.136 , 0.167 0.136 , 0.167	Depositor DCC
R_{free} test set	15583 reflections (4.76%)	wwPDB-VP
Wilson B-factor (Å ²)	12.8	Xtriage
Anisotropy	0.591	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.42 , 54.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	12126	wwPDB-VP
Average B, all atoms (Å ²)	19.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.88% 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: CL, FE, BME, 3N8, MHO, MUC, CSO, 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	0.51	0/1655	0.69	0/2254
1	C	0.51	0/1653	0.71	0/2251
1	E	0.51	0/1659	0.69	0/2259
2	B	0.57	0/2001	0.73	0/2723
2	F	0.53	0/1984	0.74	0/2701
3	D	0.55	0/1979	0.72	0/2691
All	All	0.53	0/10931	0.72	0/14879

There are no bond length outliers.

There are no bond angle outliers.

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	1614	0	1548	9	0
1	C	1612	0	1552	14	0
1	E	1618	0	1552	15	0
2	B	1944	0	1897	19	0
2	F	1928	0	1879	19	0
3	D	1941	0	1896	19	0
4	A	9	0	4	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	27	0	9	3	0
4	C	9	0	5	0	0
4	D	27	0	9	4	0
4	E	9	0	3	0	0
4	F	36	0	13	3	0
5	A	5	0	0	0	0
6	B	1	0	0	0	0
6	D	1	0	0	0	0
6	F	1	0	0	0	0
7	B	4	0	6	1	0
7	C	8	0	12	0	0
7	F	4	0	6	0	0
8	B	2	0	0	0	0
8	F	1	0	0	0	0
9	C	10	0	5	1	0
9	E	10	0	5	1	0
10	A	186	0	0	0	0
10	B	263	0	0	4	1
10	C	200	0	0	0	0
10	D	255	0	0	3	2
10	E	155	0	0	2	0
10	F	246	0	0	2	0
All	All	12126	0	10401	86	3

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 4.

All (86) 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:19:ILE:HG22	2:B:426[A]:VAL:HG22	1.67	0.74
3:D:429:CSO:OD	10:D:934:HOH:O	2.02	0.71
1:C:64:ARG:NE	1:C:99:PHE:O	2.26	0.69
1:E:165:GLN:H	1:E:165:GLN:HE21	1.40	0.68
1:C:70:VAL:HG11	1:C:106[A]:LEU:HD21	1.75	0.67
2:F:426[A]:VAL:HG22	1:E:19:ILE:HG22	1.78	0.66
1:A:133:ARG:HG2	2:B:326[A]:THR:HG21	1.79	0.65
1:C:51:LEU:HD11	1:C:126[B]:ILE:CD1	2.30	0.62
1:C:19:ILE:HG22	3:D:426[A]:VAL:HG22	1.82	0.61
3:D:447[B]:TYR:HB2	3:D:448:PRO:HD2	1.83	0.60
2:F:326[A]:THR:HG21	1:E:133:ARG:HG2	1.83	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:F:447[B]:TYR:CE2	2:F:460:HIS:HE1	2.21	0.58
3:D:361:HIS:CD2	3:D:361:HIS:H	2.23	0.57
1:C:172:ALA:HA	9:C:304:MUC:H5	1.88	0.55
3:D:447[B]:TYR:CE2	3:D:460:HIS:HE1	2.25	0.55
2:B:361:HIS:H	2:B:361:HIS:CD2	2.25	0.54
3:D:478:LEU:C	3:D:478:LEU:HD23	2.32	0.54
1:E:172:ALA:HA	9:E:302:MUC:H5	1.90	0.54
2:F:447[B]:TYR:CE2	2:F:460:HIS:CE1	2.96	0.53
2:B:329:ALA:HB3	10:B:913:HOH:O	2.08	0.53
3:D:408:TYR:HE2	3:D:447[B]:TYR:CZ	2.26	0.53
1:E:18[A]:HIS:CE1	10:E:404:HOH:O	2.61	0.53
1:E:70:VAL:HG11	1:E:106:LEU:HD21	1.91	0.53
1:A:19:ILE:CG2	2:B:426[A]:VAL:HG22	2.38	0.52
2:B:408:TYR:HE2	2:B:447[A]:TYR:CZ	2.27	0.52
3:D:408:TYR:HE2	3:D:447[B]:TYR:CE2	2.27	0.52
1:C:39:LEU:HD13	1:C:106[B]:LEU:HD11	1.91	0.52
2:B:447[A]:TYR:HB2	2:B:448:PRO:HD2	1.92	0.52
3:D:329:ALA:HB3	10:D:928:HOH:O	2.08	0.51
1:E:18[A]:HIS:HE1	10:E:404:HOH:O	1.92	0.51
2:F:478:LEU:C	2:F:478:LEU:HD23	2.36	0.51
2:F:408:TYR:HE2	2:F:447[B]:TYR:CZ	2.28	0.50
1:C:134:GLY:HA2	3:D:326[B]:THR:HG23	1.92	0.50
2:B:447[A]:TYR:CE2	2:B:460:HIS:HE1	2.29	0.50
2:F:361:HIS:H	2:F:361:HIS:CD2	2.28	0.50
3:D:497:ASN:HD22	3:D:497:ASN:C	2.21	0.49
2:B:415:TYR:HB2	10:B:907:HOH:O	2.13	0.49
4:F:605[B]:3N8:H3	1:E:16:TYR:CD2	2.47	0.49
1:C:16:TYR:CD2	4:D:602[B]:3N8:H3	2.47	0.49
1:C:15:PRO:HD2	4:D:602[B]:3N8:C6	2.42	0.49
1:A:51:LEU:HD11	1:A:126[B]:ILE:CD1	2.43	0.48
2:F:369:ASN:H	2:F:422:ASN:HD22	1.60	0.48
2:B:408:TYR:HE2	2:B:447[A]:TYR:CE2	2.31	0.48
7:B:602:BME:H22	10:B:713:HOH:O	2.14	0.48
2:B:326[A]:THR:HG22	2:B:330:ARG:HD2	1.96	0.48
1:E:51:LEU:HD11	1:E:126:ILE:CD1	2.44	0.48
1:A:70:VAL:HG11	1:A:106:LEU:HD11	1.96	0.47
2:F:414:ARG:HA	10:F:868:HOH:O	2.14	0.47
2:F:497:ASN:C	2:F:497:ASN:HD22	2.22	0.47
3:D:408:TYR:CE2	3:D:447[B]:TYR:CE2	3.02	0.47
1:A:15:PRO:HD2	4:B:603[B]:3N8:C6	2.44	0.47
2:B:478:LEU:HD23	2:B:478:LEU:C	2.39	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:F:301:PRO:HD2	1:E:80:GLN:HE22	1.79	0.47
2:F:447[B]:TYR:HB2	2:F:448:PRO:HD2	1.95	0.47
2:F:408:TYR:CE2	2:F:447[B]:TYR:CE2	3.03	0.47
2:F:408:TYR:HE2	2:F:447[B]:TYR:CE2	2.33	0.47
4:F:605[B]:3N8:C6	1:E:15:PRO:HD2	2.45	0.46
2:B:497:ASN:C	2:B:497:ASN:HD22	2.24	0.46
2:F:301:PRO:HD2	1:E:80:GLN:NE2	2.30	0.46
2:F:415:TYR:HB2	10:F:903:HOH:O	2.16	0.45
2:B:408:TYR:CE2	2:B:447[A]:TYR:CE2	3.04	0.45
2:B:447[A]:TYR:CE2	2:B:460:HIS:CE1	3.04	0.45
3:D:447[B]:TYR:CE2	3:D:460:HIS:CE1	3.05	0.44
3:D:369:ASN:H	3:D:422:ASN:HD22	1.64	0.44
2:B:369:ASN:H	2:B:422:ASN:HD22	1.63	0.44
1:A:16:TYR:CD2	4:B:603[B]:3N8:H3	2.53	0.44
3:D:324:TYR:CE1	3:D:326[B]:THR:HG22	2.53	0.44
1:A:52[A]:LEU:C	1:A:52[A]:LEU:HD12	2.43	0.43
1:C:39:LEU:HD13	1:C:106[B]:LEU:CD1	2.48	0.43
1:C:16:TYR:CD2	4:D:602[A]:3N8:H1	2.53	0.43
2:F:416:LEU:HD23	2:F:417:ALA:N	2.34	0.43
4:F:605[A]:3N8:H1	1:E:16:TYR:CD2	2.54	0.43
3:D:447[B]:TYR:HB2	3:D:448:PRO:CD	2.48	0.43
3:D:415:TYR:HB2	10:D:930:HOH:O	2.18	0.43
2:B:368:ASN:C	2:B:368:ASN:HD22	2.27	0.42
1:E:52:LEU:HD22	1:E:52:LEU:C	2.45	0.42
2:B:497:ASN:HD22	2:B:499:GLU:H	1.66	0.42
2:F:326[A]:THR:HG22	2:F:330:ARG:HD2	2.02	0.41
1:C:133:ARG:HG2	3:D:326[A]:THR:HG21	2.02	0.41
2:B:524:ASP:HB3	10:B:942:HOH:O	2.19	0.41
1:C:131:PHE:CE2	1:C:138:HIS:HB3	2.56	0.41
2:F:447[B]:TYR:CZ	2:F:460:HIS:HE1	2.39	0.40
1:A:16:TYR:CD2	4:B:603[A]:3N8:H1	2.55	0.40
1:C:15:PRO:HD2	4:D:602[A]:3N8:C3	2.50	0.40
3:D:400:TRP:HA	3:D:425:GLY:O	2.21	0.40
1:E:144:TYR:CE1	1:E:158[A]:LEU:HD13	2.56	0.40

All (3) 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)
10:D:702:HOH:O	10:D:726:HOH:O[4_555]	1.64	0.56

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
10:D:726:HOH:O	10:D:726:HOH:O[4_555]	1.72	0.48
10:B:741:HOH:O	10:B:741:HOH:O[2_555]	2.10	0.10

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	203/200 (102%)	201 (99%)	2 (1%)	0	100	100
1	C	202/200 (101%)	199 (98%)	3 (2%)	0	100	100
1	E	203/200 (102%)	199 (98%)	4 (2%)	0	100	100
2	B	243/238 (102%)	238 (98%)	5 (2%)	0	100	100
2	F	241/238 (101%)	237 (98%)	4 (2%)	0	100	100
3	D	240/238 (101%)	234 (98%)	6 (2%)	0	100	100
All	All	1332/1314 (101%)	1308 (98%)	24 (2%)	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	168/163 (103%)	166 (99%)	2 (1%)	63	32
1	C	168/163 (103%)	165 (98%)	3 (2%)	51	19
1	E	168/163 (103%)	161 (96%)	7 (4%)	26	3

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	B	210/202 (104%)	205 (98%)	5 (2%)	43	12
2	F	208/202 (103%)	202 (97%)	6 (3%)	37	8
3	D	207/200 (104%)	202 (98%)	5 (2%)	43	12
All	All	1129/1093 (103%)	1101 (98%)	28 (2%)	45	10

All (28) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	114[A]	VAL
1	A	114[B]	VAL
2	F	372	LEU
2	F	390	LYS
2	F	395	THR
2	F	416	LEU
2	F	478	LEU
2	F	497	ASN
1	E	52	LEU
1	E	106	LEU
1	E	114[A]	VAL
1	E	114[B]	VAL
1	E	158[A]	LEU
1	E	158[B]	LEU
1	E	165	GLN
1	C	100	ASP
1	C	106[A]	LEU
1	C	106[B]	LEU
3	D	395	THR
3	D	411	LYS
3	D	416	LEU
3	D	478	LEU
3	D	497	ASN
2	B	395	THR
2	B	411	LYS
2	B	416	LEU
2	B	442	ILE
2	B	497	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (28) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	28	ASN
1	A	59	ASN
2	F	334	GLN
2	F	361	HIS
2	F	368	ASN
2	F	412	ASN
2	F	422	ASN
2	F	497	ASN
2	F	530	GLN
1	E	59	ASN
1	E	80	GLN
1	E	159	ASN
1	E	165	GLN
1	C	59	ASN
3	D	334	GLN
3	D	361	HIS
3	D	368	ASN
3	D	412	ASN
3	D	422	ASN
3	D	497	ASN
3	D	503	GLN
3	D	530	GLN
2	B	334	GLN
2	B	361	HIS
2	B	368	ASN
2	B	412	ASN
2	B	422	ASN
2	B	497	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues are 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	$\# Z > 2$
3	CSO	D	429	3	3,6,7	0.79	0	1,6,8	0.07	0
3	MHO	D	488	3	6,8,9	1.12	0	3,9,11	1.58	1 (33%)

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	CSO	D	429	3	-	0/1/5/7	-
3	MHO	D	488	3	-	2/6/7/9	-

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	488	MHO	CE-SD-CG	-2.44	91.34	97.45

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	D	488	MHO	CB-CG-SD-CE
3	D	488	MHO	CB-CG-SD-OD1

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	D	429	CSO	1	0

5.5 Carbohydrates

There are no oligosaccharides in this entry.

5.6 Ligand geometry

Of 26 ligands modelled in this entry, 6 are monoatomic - leaving 20 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$
4	3N8	E	301	-	9,9,9	0.76	0	12,12,12	1.00	1 (8%)
4	3N8	B	604	-	9,9,9	0.71	0	12,12,12	1.05	0
9	MUC	C	304	-	10,10,10	2.00	1 (10%)	13,13,13	2.65	6 (46%)
7	BME	F	603	-	3,3,3	0.20	0	2,2,2	0.09	0
4	3N8	B	603[B]	-	9,9,9	0.64	0	12,12,12	1.09	1 (8%)
7	BME	C	302	-	3,3,3	0.32	0	2,2,2	0.12	0
4	3N8	D	602[B]	-	9,9,9	0.69	0	12,12,12	1.10	1 (8%)
4	3N8	F	605[B]	-	9,9,9	0.59	0	12,12,12	1.16	1 (8%)
4	3N8	D	603	-	9,9,9	0.82	0	12,12,12	1.16	1 (8%)
4	3N8	B	603[A]	-	9,9,9	0.73	0	12,12,12	1.19	2 (16%)
4	3N8	F	602	-	9,9,9	0.65	0	12,12,12	1.08	1 (8%)
4	3N8	A	301	-	9,9,9	0.77	0	12,12,12	1.10	1 (8%)
7	BME	B	602	-	3,3,3	0.30	0	2,2,2	0.08	0
7	BME	C	303	-	3,3,3	0.35	0	2,2,2	0.53	0
4	3N8	D	602[A]	-	9,9,9	0.74	0	12,12,12	1.21	2 (16%)
9	MUC	E	302	-	10,10,10	1.88	1 (10%)	13,13,13	2.74	9 (69%)
4	3N8	F	604	-	9,9,9	0.77	0	12,12,12	0.95	0
4	3N8	F	605[A]	-	9,9,9	0.64	0	12,12,12	1.19	2 (16%)
4	3N8	C	301	-	9,9,9	0.85	0	12,12,12	1.10	1 (8%)
5	SO4	A	302	-	4,4,4	0.43	0	6,6,6	0.08	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
4	3N8	E	301	-	-	-	0/1/1/1

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	3N8	B	604	-	-	-	0/1/1/1
9	MUC	C	304	-	-	3/4/13/13	0/1/1/1
7	BME	F	603	-	-	1/1/1/1	-
4	3N8	B	603[B]	-	-	-	0/1/1/1
7	BME	C	302	-	-	0/1/1/1	-
4	3N8	D	602[B]	-	-	-	0/1/1/1
4	3N8	F	605[B]	-	-	-	0/1/1/1
4	3N8	D	603	-	-	-	0/1/1/1
4	3N8	B	603[A]	-	-	-	0/1/1/1
4	3N8	F	602	-	-	-	0/1/1/1
4	3N8	A	301	-	-	-	0/1/1/1
7	BME	B	602	-	-	1/1/1/1	-
7	BME	C	303	-	-	1/1/1/1	-
9	MUC	E	302	-	-	3/4/13/13	0/1/1/1
4	3N8	D	602[A]	-	-	-	0/1/1/1
4	3N8	F	604	-	-	-	0/1/1/1
4	3N8	F	605[A]	-	-	-	0/1/1/1
4	3N8	C	301	-	-	-	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
9	C	304	MUC	O3-C6	5.81	1.46	1.36
9	E	302	MUC	O3-C6	5.45	1.45	1.36

All (29) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
9	C	304	MUC	C3-O3-C6	-5.91	104.40	109.16
9	E	302	MUC	C3-O3-C6	-5.46	104.76	109.16
9	E	302	MUC	C2-C3-C4	-4.80	103.42	113.83
9	C	304	MUC	O6-C6-C5	-3.43	125.17	130.85
9	C	304	MUC	O3-C6-O6	3.37	125.01	120.93
9	C	304	MUC	C2-C3-C4	-3.29	106.69	113.83
9	C	304	MUC	O3-C3-C4	2.87	106.72	103.41
9	E	302	MUC	O6-C6-C5	-2.78	126.24	130.85
4	D	602[A]	3N8	C5-C4-C3	-2.63	119.76	123.23
4	F	605[B]	3N8	C5-C4-C3	-2.62	119.77	123.23
9	E	302	MUC	O3-C3-C4	2.61	106.43	103.41
4	B	603[A]	3N8	C5-C4-C3	-2.52	119.90	123.23
9	E	302	MUC	O3-C6-C5	2.49	109.83	108.17
4	D	602[B]	3N8	C5-C4-C3	-2.48	119.96	123.23

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
9	C	304	MUC	O3-C6-C5	2.47	109.82	108.17
9	E	302	MUC	O3-C6-O6	2.46	123.91	120.93
4	B	603[B]	3N8	C5-C4-C3	-2.45	120.00	123.23
4	D	603	3N8	C5-C4-C3	-2.43	120.02	123.23
4	A	301	3N8	C5-C4-C3	-2.39	120.07	123.23
4	F	605[A]	3N8	C5-C4-C3	-2.33	120.15	123.23
4	F	605[A]	3N8	C2-C3-C4	2.30	120.66	118.31
4	C	301	3N8	C5-C4-C3	-2.29	120.21	123.23
4	E	301	3N8	C5-C4-C3	-2.22	120.30	123.23
9	E	302	MUC	O3-C3-C2	2.20	111.64	108.76
9	E	302	MUC	O1-C1-C2	2.18	120.79	114.00
4	D	602[A]	3N8	C2-C3-C4	2.15	120.51	118.31
4	B	603[A]	3N8	C2-C3-C4	2.09	120.44	118.31
4	F	602	3N8	C5-C4-C3	-2.08	120.48	123.23
9	E	302	MUC	O2-C1-C2	-2.00	116.70	122.84

There are no chirality outliers.

All (9) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
7	F	603	BME	O1-C1-C2-S2
9	C	304	MUC	C1-C2-C3-C4
9	C	304	MUC	C1-C2-C3-O3
7	C	303	BME	O1-C1-C2-S2
7	B	602	BME	O1-C1-C2-S2
9	E	302	MUC	C1-C2-C3-C4
9	C	304	MUC	O1-C1-C2-C3
9	E	302	MUC	O2-C1-C2-C3
9	E	302	MUC	O1-C1-C2-C3

There are no ring outliers.

9 monomers are involved in 13 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
9	C	304	MUC	1	0
4	B	603[B]	3N8	2	0
4	D	602[B]	3N8	2	0
4	F	605[B]	3N8	2	0
4	B	603[A]	3N8	1	0
7	B	602	BME	1	0
4	D	602[A]	3N8	2	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
9	E	302	MUC	1	0
4	F	605[A]	3N8	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 ⓘ

6.1 Protein, DNA and RNA chains ⓘ

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	200/200 (100%)	0.76	18 (9%)	15 21	7, 17, 32, 52	5 (2%)
1	C	200/200 (100%)	0.75	14 (7%)	22 30	7, 17, 28, 49	5 (2%)
1	E	200/200 (100%)	1.13	32 (16%)	5 8	9, 20, 38, 59	5 (2%)
2	B	238/238 (100%)	0.60	15 (6%)	26 34	7, 15, 25, 45	8 (3%)
2	F	238/238 (100%)	0.76	18 (7%)	20 28	7, 16, 27, 44	7 (2%)
3	D	236/238 (99%)	0.66	19 (8%)	18 25	8, 15, 24, 45	7 (2%)
All	All	1312/1314 (99%)	0.77	116 (8%)	15 22	7, 16, 30, 59	37 (2%)

All (116) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	D	416	LEU	6.6
2	F	416	LEU	6.4
1	A	25	ALA	5.7
3	D	538[A]	CYS	5.4
1	E	27	GLY	5.3
2	F	538[A]	CYS	5.0
1	A	99	PHE	4.7
1	E	25	ALA	4.6
2	B	416	LEU	4.5
2	B	442	ILE	4.4
1	E	102	GLY	4.1
1	E	98[A]	THR	4.0
2	B	447[A]	TYR	4.0
1	E	99	PHE	3.9
2	F	537	ASN	3.6
1	E	23	LEU	3.5
2	F	370	GLY	3.5
2	F	367	PHE	3.5
2	B	538[A]	CYS	3.4

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Mol	Chain	Res	Type	RSRZ
1	A	179	GLY	3.3
2	B	367	PHE	3.3
3	D	414	ARG	3.3
2	B	372	LEU	3.3
1	C	43	ASP	3.3
2	F	368	ASN	3.3
2	B	369	ASN	3.3
3	D	369	ASN	3.3
1	E	42	PRO	3.2
2	B	368	ASN	3.2
1	A	27	GLY	3.2
2	F	372	LEU	3.2
3	D	368	ASN	3.1
2	F	301	PRO	3.1
3	D	374	ILE	3.0
1	E	179	GLY	3.0
1	A	43	ASP	3.0
2	B	371	GLY	2.9
1	C	99	PHE	2.8
3	D	364[A]	LEU	2.8
1	C	100	ASP	2.7
1	A	85	LEU	2.7
1	E	160	LEU	2.7
1	C	25	ALA	2.7
1	A	177	VAL	2.7
1	E	101	ALA	2.7
1	E	19	ILE	2.6
1	C	24	GLU	2.6
3	D	430[A]	LEU	2.6
2	B	537	ASN	2.6
1	A	119	GLY	2.6
1	C	42	PRO	2.6
3	D	303	GLN	2.6
3	D	390	LYS	2.6
1	C	106[A]	LEU	2.6
1	E	26	ALA	2.6
3	D	411	LYS	2.5
1	A	24	GLU	2.5
2	F	414	ARG	2.5
1	A	102	GLY	2.5
2	F	442	ILE	2.5
1	C	101	ALA	2.5

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Mol	Chain	Res	Type	RSRZ
1	E	28	ASN	2.4
3	D	367	PHE	2.4
2	B	498	PRO	2.4
2	F	499	GLU	2.4
1	E	50	LEU	2.3
1	A	16	TYR	2.3
1	A	98	THR	2.3
1	E	70	VAL	2.3
1	E	100	ASP	2.3
3	D	537	ASN	2.3
1	C	19	ILE	2.3
2	B	394	ASN	2.3
1	A	114[A]	VAL	2.3
1	E	109	VAL	2.3
1	E	114[A]	VAL	2.3
3	D	371	GLY	2.3
1	E	45	PRO	2.3
1	E	175	CYS	2.3
3	D	442	ILE	2.3
1	A	42	PRO	2.3
1	E	40	ALA	2.2
1	C	98	THR	2.2
1	E	32	ASP	2.2
1	E	85	LEU	2.2
1	E	106	LEU	2.2
3	D	301	PRO	2.2
2	F	303	GLN	2.2
2	F	394	ASN	2.2
3	D	410	HIS	2.2
2	B	414	ARG	2.2
2	B	535	PHE	2.2
3	D	372	LEU	2.2
2	F	302	ALA	2.2
1	A	23	LEU	2.1
1	A	64	ARG	2.1
1	C	21	LEU	2.1
1	E	16	TYR	2.1
2	B	411	LYS	2.1
1	A	176	GLU	2.1
1	E	158[A]	LEU	2.1
1	E	76	ASN	2.1
1	A	40	ALA	2.1

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Mol	Chain	Res	Type	RSRZ
1	E	44	ALA	2.1
1	E	177	VAL	2.1
2	F	411	LYS	2.1
1	E	150	GLN	2.1
1	E	117	ALA	2.1
1	C	20	GLY	2.0
3	D	370	GLY	2.0
1	E	52	LEU	2.0
2	F	358	ALA	2.0
2	F	532	LYS	2.0
1	C	86	GLU	2.0
2	F	418	PRO	2.0
1	C	157	VAL	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [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
3	MHO	D	488	9/10	0.92	0.16	16,18,31,37	0
3	CSO	D	429	7/8	0.96	0.12	13,14,18,22	1

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
7	BME	C	303	4/4	0.78	0.16	26,35,40,56	0
7	BME	C	302	4/4	0.81	0.16	36,38,43,49	0
4	3N8	D	603	9/9	0.81	0.16	32,36,42,54	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
9	MUC	C	304	10/10	0.81	0.15	24,33,56,57	0
9	MUC	E	302	10/10	0.82	0.13	29,35,52,52	0
7	BME	F	603	4/4	0.82	0.16	32,33,43,43	0
4	3N8	F	602	9/9	0.84	0.14	30,31,39,49	0
4	3N8	F	604	9/9	0.85	0.13	24,28,35,41	0
7	BME	B	602	4/4	0.86	0.15	29,32,43,51	0
4	3N8	C	301	9/9	0.89	0.13	27,28,32,32	0
4	3N8	B	604	9/9	0.89	0.13	25,27,35,42	0
5	SO4	A	302	5/5	0.90	0.13	26,31,35,36	5
4	3N8	F	605[A]	9/9	0.91	0.13	15,16,18,21	9
4	3N8	F	605[B]	9/9	0.91	0.13	16,17,18,22	9
4	3N8	E	301	9/9	0.92	0.12	29,30,37,38	0
8	CL	B	605	1/1	0.92	0.13	49,49,49,49	0
4	3N8	A	301	9/9	0.93	0.09	23,25,30,31	0
4	3N8	D	602[A]	9/9	0.95	0.09	15,17,18,18	9
4	3N8	D	602[B]	9/9	0.95	0.09	15,16,18,20	9
4	3N8	B	603[B]	9/9	0.96	0.09	16,18,19,23	9
4	3N8	B	603[A]	9/9	0.96	0.09	15,16,18,19	9
8	CL	F	606	1/1	0.97	0.08	43,43,43,43	0
8	CL	B	606	1/1	0.98	0.10	35,35,35,35	0
6	FE	F	601	1/1	1.00	0.02	14,14,14,14	1
6	FE	D	601	1/1	1.00	0.02	13,13,13,13	1
6	FE	B	601	1/1	1.00	0.02	14,14,14,14	1

6.5 Other polymers

There are no such residues in this entry.