WORLDWIDE wwPDB PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report (i)

Oct 8, 2024 – 01:05 AM EDT

PDB ID	:	3RWK
Title	:	First crystal structure of an endo-inulinase, from Aspergillus ficuum: structural analysis and comparison with other GH32 enzymes.
Authors	:	Michaux, C.; Pouyez, J.; Roussel, G.; Mayard, A.; Vandamme, A.M.; Housen, I.; Wouters, J.
Deposited on	:	2011-05-09
Resolution	:	2.10 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 (i) 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 (i)) were used in the production of this report:

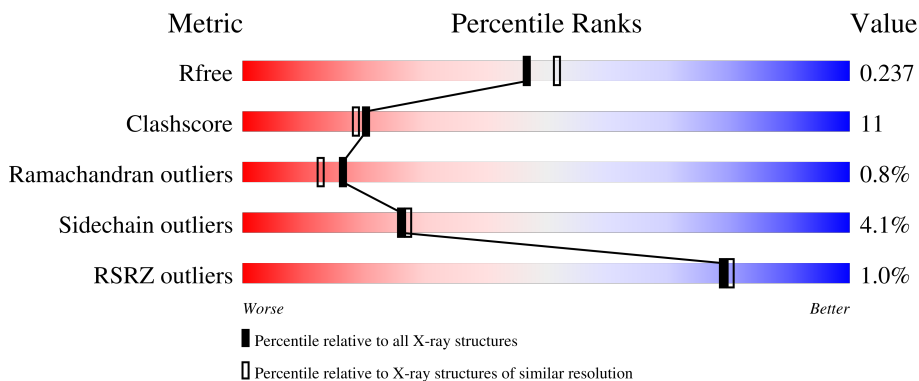|		
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.20.1
EDS	:	3.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.39

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	Percentile Ranks	Value
Rfree		0.237
Clashscore		11
Ramachandran outliers		0.8%
Sidechain outliers		4.1%
RSRZ outliers		1.0%

Worse   *Better*

▮ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	6234 (2.10-2.10)
Clashscore	180529	6893 (2.10-2.10)
Ramachandran outliers	177936	6839 (2.10-2.10)
Sidechain outliers	177891	6840 (2.10-2.10)
RSRZ outliers	164620	6234 (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 <=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	X	516	82% 12% · · ·
2	A	3	33% 67%
3	B	3	33% 67%

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

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	MAN	A	2	-	-	X	-
4	FRU	X	520	-	-	X	-
4	FRU	X	801	-	-	X	-

2 Entry composition ⓘ

There are 8 unique types of molecules in this entry. The entry contains 4155 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 Inulinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	X	493	Total	C	N	O	S	0	0	0
			3756	2358	630	757	11			

- Molecule 2 is an oligosaccharide called alpha-D-mannopyranose-(1-3)-alpha-D-mannopyranose-(1-6)-alpha-D-mannopyranose.

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
2	A	3	Total	C	O	0	0	0
			33	18	15			

- Molecule 3 is an oligosaccharide called beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose.
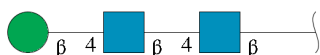
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
3	B	3	Total	C	N	O	0	0	0
			37	21	2	14			

- Molecule 4 is beta-D-fructofuranose (three-letter code: FRU) (formula: $C_6H_{12}O_6$).
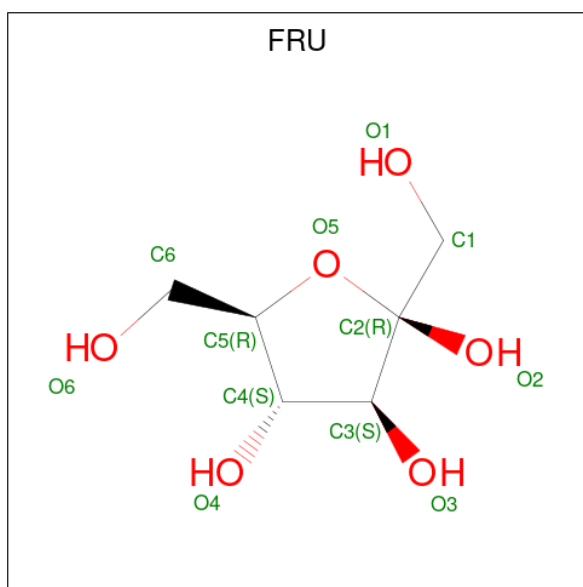
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	X	1	Total 12	C 6	O 6	0	0
4	X	1	Total 12	C 6	O 6	0	0

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	X	1	Total 1	Na 1	0	0

- Molecule 6 is SULFATE ION (three-letter code: SO4) (formula: O_4S).
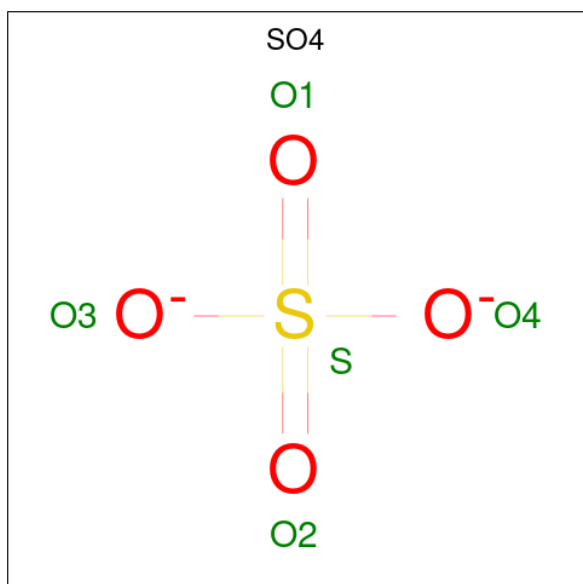
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	O	S		
6	X	1	5	4	1	0	0

• Molecule 7 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2$).
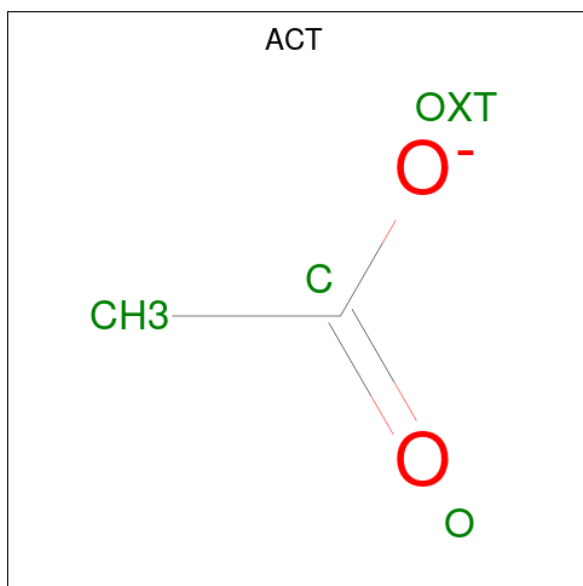
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
7	X	1	4	2	2	0	0

• Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
8	X	295	295	295	0	0

3 Residue-property plots ⓘ

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: Inulinase

Chain X:
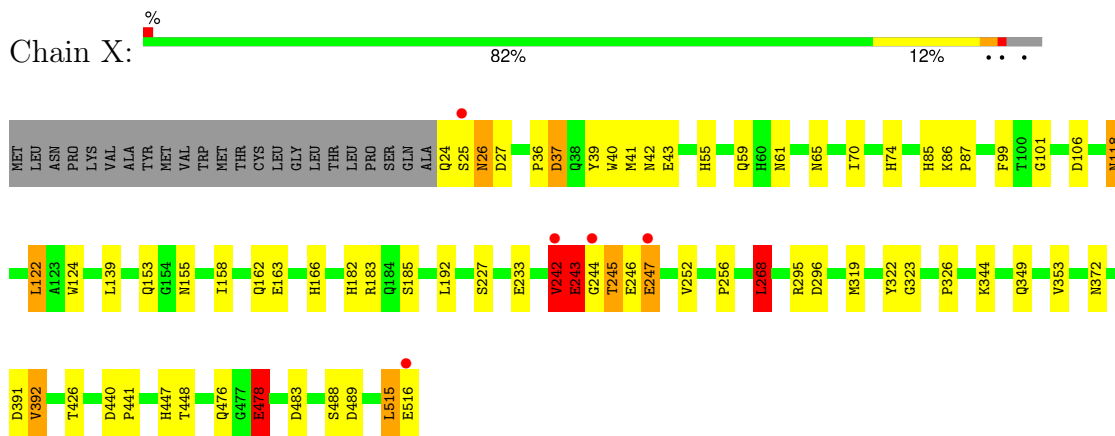
- Molecule 2: alpha-D-mannopyranose-(1-3)-alpha-D-mannopyranose-(1-6)-alpha-D-mannopyranose

Chain A:

- Molecule 3: beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose

Chain B:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α, β, γ	95.76Å　　95.76Å　　130.82Å 90.00°　　90.00°　　120.00°	Depositor
Resolution (Å)	9.99　–　2.10 9.99　–　2.10	Depositor EDS
% Data completeness (in resolution range)	100.0 (9.99-2.10) 98.9 (9.99-2.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.91 (at 2.09Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.183　,　0.232 0.190　,　0.237	Depositor DCC
R_{free} test set	2047 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å^2)	32.4	Xtriage
Anisotropy	0.129	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.40 , 49.3	EDS
L-test for twinning [2]	$< |L| > = 0.48, < L^2 > = 0.31$	Xtriage
Estimated twinning fraction	0.032 for -h,-k,l	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	4155	wwPDB-VP
Average B, all atoms (Å^2)	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.94% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: MAN, NA, ACT, FRU, NAG, SO4, BMA

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	X	0.92	0/3853	0.86	5/5269 (0.1%)

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	X	0	3

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	268	LEU	CB-CG-CD2	5.80	120.85	111.00
1	X	268	LEU	CB-CG-CD1	5.44	120.25	111.00
1	X	268	LEU	CA-CB-CG	5.20	127.26	115.30
1	X	37	ASP	CB-CG-OD1	5.17	122.96	118.30
1	X	478	GLU	CB-CA-C	-5.04	100.31	110.40

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	X	242	VAL	Peptide
1	X	243	GLU	Peptide
1	X	515	LEU	Peptide

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	X	3756	0	3557	75	0
2	A	33	0	29	6	2
3	B	37	0	30	5	2
4	X	24	0	23	13	0
5	X	1	0	0	0	0
6	X	5	0	0	0	0
7	X	4	0	3	0	0
8	X	295	0	0	8	0
All	All	4155	0	3642	81	2

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 11.

The worst 5 of 81 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:X:372:ASN:HD21	3:B:1:NAG:C1	0.89	1.53
1:X:40:TRP:HB3	4:X:520:FRU:H3	1.20	1.08
1:X:242:VAL:O	1:X:242:VAL:HG23	1.56	1.02
1:X:43:GLU:OE2	4:X:801:FRU:H5	1.70	0.91
1:X:515:LEU:O	1:X:516:GLU:HG3	1.70	0.91

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

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:A:2:MAN:O6	3:B:3:BMA:C5[6_655]	1.40	0.80
2:A:2:MAN:C6	3:B:3:BMA:C5[6_655]	2.16	0.04

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	X	491/516 (95%)	470 (96%)	17 (4%)	4 (1%)	16	13

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	X	243	GLU
1	X	245	THR
1	X	39	TYR
1	X	246	GLU

5.3.2 Protein sidechains ⓘ

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	X	411/431 (95%)	394 (96%)	17 (4%)	26	27

5 of 17 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	X	392	VAL
1	X	488	SER
1	X	242	VAL
1	X	243	GLU
1	X	247	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 11 such sidechains are listed below:

Mol	Chain	Res	Type
1	X	325	ASN
1	X	372	ASN
1	X	447	HIS
1	X	415	GLN
1	X	166	HIS

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 ⓘ

6 monosaccharides 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	$\#|Z| > 2$
2	MAN	A	1	2	11,11,12	0.77	0	15,15,17	2.57	7 (46%)
2	MAN	A	2	2	11,11,12	0.78	0	15,15,17	2.47	8 (53%)
2	MAN	A	3	2	11,11,12	0.91	0	15,15,17	1.89	4 (26%)
3	NAG	B	1	1,3	14,14,15	0.49	0	17,19,21	1.76	4 (23%)
3	NAG	B	2	3	14,14,15	0.44	0	17,19,21	1.88	4 (23%)
3	BMA	B	3	3	9,9,12	0.71	0	10,12,17	2.93	2 (20%)

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.

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	MAN	A	1	2	-	0/2/19/22	0/1/1/1
2	MAN	A	2	2	-	1/2/19/22	0/1/1/1
2	MAN	A	3	2	-	0/2/19/22	0/1/1/1
3	NAG	B	1	1,3	-	0/6/23/26	0/1/1/1
3	NAG	B	2	3	-	0/6/23/26	0/1/1/1
3	BMA	B	3	3	-	-	0/1/1/1

There are no bond length outliers.

The worst 5 of 29 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	B	3	BMA	C5-O5-C1	6.78	122.36	111.42
3	B	3	BMA	C5-C4-C3	5.29	117.35	109.64
2	A	1	MAN	C1-C2-C3	4.56	116.28	109.64
2	A	2	MAN	O4-C4-C3	-4.33	100.16	110.38
2	A	2	MAN	C2-C3-C4	4.33	118.48	110.86

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	2	MAN	C4-C5-C6-O6

There are no ring outliers.

4 monomers are involved in 13 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	1	NAG	5	0
2	A	1	MAN	4	0
3	B	3	BMA	0	2
2	A	2	MAN	5	2

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.

Oligosaccharide Chain A	

Bond lengths |

Bond angles |
|

Torsions |

Rings |

Oligosaccharide Chain B	

Bond lengths |

Bond angles |
|

Torsions |

Rings |
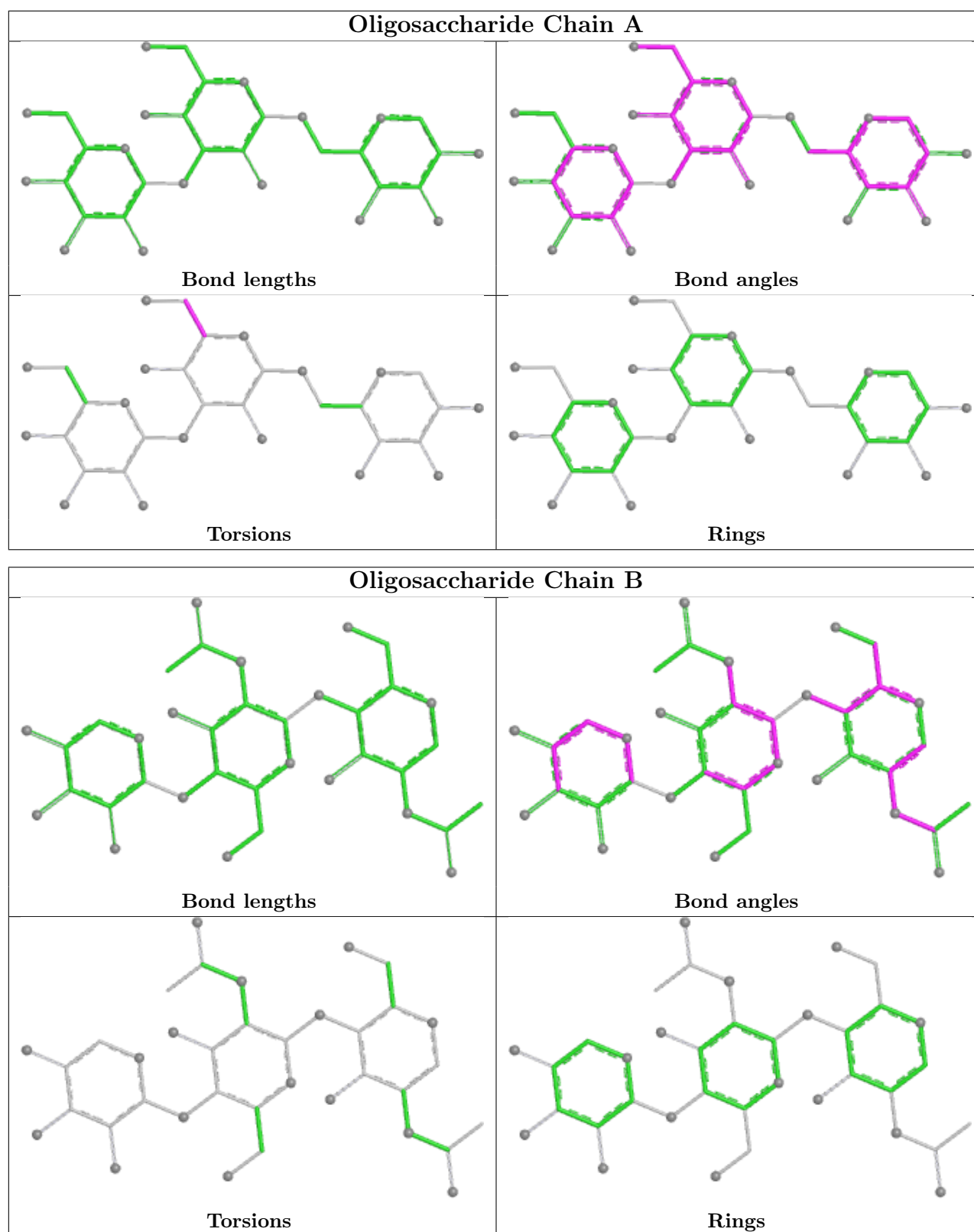
5.6 Ligand geometry ⓘ

Of 5 ligands modelled in this entry, 1 is monoatomic - leaving 4 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	#$|Z| > 2$
7	ACT	X	1428	-	3,3,3	0.83	0	3,3,3	0.53	0
4	FRU	X	520	-	11,12,12	1.47	1 (9%)	10,18,18	2.54	5 (50%)
6	SO4	X	995	-	4,4,4	0.36	0	6,6,6	0.96	0
4	FRU	X	801	-	11,12,12	2.04	4 (36%)	10,18,18	2.16	5 (50%)

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	FRU	X	520	-	-	1/5/24/24	0/1/1/1
4	FRU	X	801	-	-	5/5/24/24	0/1/1/1

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	X	801	FRU	O5-C2	-4.34	1.36	1.43
4	X	520	FRU	O2-C2	4.32	1.48	1.40
4	X	801	FRU	O3-C3	-2.53	1.37	1.42
4	X	801	FRU	C1-C2	-2.47	1.47	1.52
4	X	801	FRU	O4-C4	-2.07	1.37	1.43

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	X	520	FRU	O3-C3-C4	-4.88	96.01	113.25
4	X	801	FRU	C6-C5-C4	-3.75	106.25	115.10
4	X	520	FRU	C6-C5-C4	-3.46	106.94	115.10
4	X	520	FRU	O1-C1-C2	3.22	118.80	111.67
4	X	520	FRU	O6-C6-C5	-2.93	101.36	111.33

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	X	801	FRU	O1-C1-C2-C3
4	X	801	FRU	O1-C1-C2-O2
4	X	801	FRU	O1-C1-C2-O5
4	X	801	FRU	C4-C5-C6-O6
4	X	801	FRU	O5-C5-C6-O6

There are no ring outliers.

2 monomers are involved in 13 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	X	520	FRU	7	0
4	X	801	FRU	6	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 ⓘ

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	X	493/516 (95%)	-0.55	5 (1%)	79	80	20, 32, 48, 75	0

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	X	516	GLU	7.1
1	X	25	SER	4.3
1	X	242	VAL	2.2
1	X	244	GLY	2.1
1	X	247	GLU	2.1

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

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

SUGAR-RSR INFOmissingINFO

6.4 Ligands ⓘ

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	FRU	X	520	12/12	0.65	0.14	50,60,61,62	0
4	FRU	X	801	12/12	0.68	0.15	51,61,62,62	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
7	ACT	X	1428	4/4	0.93	0.09	38,38,38,39	0
6	SO4	X	995	5/5	0.98	0.04	35,35,37,42	0
5	NA	X	521	1/1	0.98	0.06	12,12,12,12	0

6.5 Other polymers ⓘ

There are no such residues in this entry.