



wwPDB X-ray Structure Validation Summary Report ⓘ

Sep 15, 2026 – 10:32 AM JST

PDB ID : 24FM / pdb_000024fm
Title : Dextran glucosidase SmDG E236S in complex with isomaltose
Authors : Saburi, W.; Ose, T.; Yao, M.; Mori, H.
Deposited on : 2026-03-02
Resolution : 2.20 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 : 4-5-2 with Phenix2.0
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 2.0
EDS : 3.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4 : 9.0.015 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.50

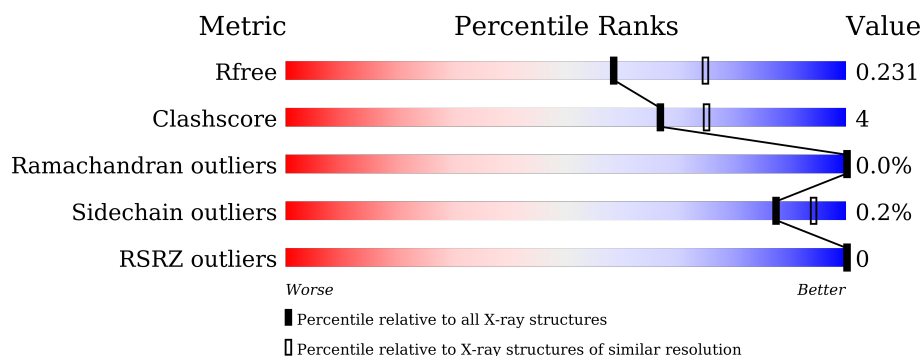
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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.



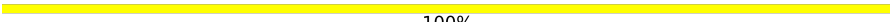
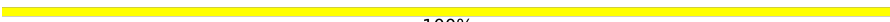
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	6164 (2.20-2.20)
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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	543	90% 9% .
1	B	543	88% 10% .
1	C	543	91% 8% .
1	D	543	87% 11% .
2	E	2	50% 50%
2	F	2	100%

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Mol	Chain	Length	Quality of chain
2	G	2	 100%
2	H	2	 100%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 18509 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 Glucan 1,6-alpha-glucosidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	536	Total	C	N	O	S	0	0	0
			4370	2794	729	825	22			
1	B	536	Total	C	N	O	S	0	0	0
			4370	2794	729	825	22			
1	C	536	Total	C	N	O	S	0	0	0
			4370	2794	729	825	22			
1	D	536	Total	C	N	O	S	0	0	0
			4370	2794	729	825	22			

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	72	ALA	THR	conflict	UNP Q99040
A	236	SER	GLU	engineered mutation	UNP Q99040
A	536	LEU	-	expression tag	UNP Q99040
A	537	GLU	-	expression tag	UNP Q99040
A	538	HIS	-	expression tag	UNP Q99040
A	539	HIS	-	expression tag	UNP Q99040
A	540	HIS	-	expression tag	UNP Q99040
A	541	HIS	-	expression tag	UNP Q99040
A	542	HIS	-	expression tag	UNP Q99040
A	543	HIS	-	expression tag	UNP Q99040
B	72	ALA	THR	conflict	UNP Q99040
B	236	SER	GLU	engineered mutation	UNP Q99040
B	536	LEU	-	expression tag	UNP Q99040
B	537	GLU	-	expression tag	UNP Q99040
B	538	HIS	-	expression tag	UNP Q99040
B	539	HIS	-	expression tag	UNP Q99040
B	540	HIS	-	expression tag	UNP Q99040
B	541	HIS	-	expression tag	UNP Q99040
B	542	HIS	-	expression tag	UNP Q99040
B	543	HIS	-	expression tag	UNP Q99040
C	72	ALA	THR	conflict	UNP Q99040

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Chain	Residue	Modelled	Actual	Comment	Reference
C	236	SER	GLU	engineered mutation	UNP Q99040
C	536	LEU	-	expression tag	UNP Q99040
C	537	GLU	-	expression tag	UNP Q99040
C	538	HIS	-	expression tag	UNP Q99040
C	539	HIS	-	expression tag	UNP Q99040
C	540	HIS	-	expression tag	UNP Q99040
C	541	HIS	-	expression tag	UNP Q99040
C	542	HIS	-	expression tag	UNP Q99040
C	543	HIS	-	expression tag	UNP Q99040
D	72	ALA	THR	conflict	UNP Q99040
D	236	SER	GLU	engineered mutation	UNP Q99040
D	536	LEU	-	expression tag	UNP Q99040
D	537	GLU	-	expression tag	UNP Q99040
D	538	HIS	-	expression tag	UNP Q99040
D	539	HIS	-	expression tag	UNP Q99040
D	540	HIS	-	expression tag	UNP Q99040
D	541	HIS	-	expression tag	UNP Q99040
D	542	HIS	-	expression tag	UNP Q99040
D	543	HIS	-	expression tag	UNP Q99040

- Molecule 2 is an oligosaccharide called alpha-D-glucopyranose-(1-6)-beta-D-glucopyranose.



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	Trace
2	E	2	Total	C	O	0	0	0
			23	12	11			
2	F	2	Total	C	O	0	0	0
			23	12	11			
2	G	2	Total	C	O	0	0	0
			23	12	11			
2	H	2	Total	C	O	0	0	0
			23	12	11			

- Molecule 3 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	2	Total	Ca	0	0
			2	2		

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	2	Total 2	Ca 2	0	0
3	C	2	Total 2	Ca 2	0	0
3	D	2	Total 2	Ca 2	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	228	Total 228	O 228	0	0
4	B	229	Total 229	O 229	0	0
4	C	230	Total 230	O 230	0	0
4	D	242	Total 242	O 242	0	0



- Molecule 2: alpha-D-glucopyranose-(1-6)-beta-D-glucopyranose



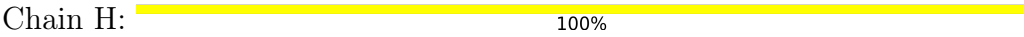
- Molecule 2: alpha-D-glucopyranose-(1-6)-beta-D-glucopyranose



- Molecule 2: alpha-D-glucopyranose-(1-6)-beta-D-glucopyranose



- Molecule 2: alpha-D-glucopyranose-(1-6)-beta-D-glucopyranose



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	134.87Å 73.06Å 135.08Å 90.00° 101.58° 90.00°	Depositor
Resolution (Å)	49.05 – 2.20 49.05 – 2.20	Depositor EDS
% Data completeness (in resolution range)	98.3 (49.05-2.20) 98.2 (49.05-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.08 (at 2.20Å)	Xtriage
Refinement program	PHENIX (1.13_2998: ???)	Depositor
R, R_{free}	0.184 , 0.232 0.186 , 0.231	Depositor DCC
R_{free} test set	2016 reflections (1.56%)	wwPDB-VP
Wilson B-factor (Å ²)	22.3	Xtriage
Anisotropy	0.539	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 16.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	0.147 for l,-k,h	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	18509	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 25.72 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 3.0085e-03. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

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: BGC, CA, GLC

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	0.32	0/4486	0.50	0/6087
1	B	0.32	0/4486	0.50	0/6087
1	C	0.32	0/4486	0.49	0/6087
1	D	0.33	0/4486	0.50	0/6087
All	All	0.32	0/17944	0.50	0/24348

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	4370	0	4210	33	0
1	B	4370	0	4210	34	0
1	C	4370	0	4210	24	0
1	D	4370	0	4210	36	0
2	E	23	0	21	0	0
2	F	23	0	21	1	0
2	G	23	0	21	0	0
2	H	23	0	21	0	0
3	A	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	2	0	0	0	0
3	C	2	0	0	0	0
3	D	2	0	0	0	0
4	A	228	0	0	4	0
4	B	229	0	0	6	0
4	C	230	0	0	2	0
4	D	242	0	0	2	0
All	All	18509	0	16924	127	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 4.

The worst 5 of 127 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:D:27:ILE:HD13	1:D:74:ILE:HD11	1.48	0.96
1:C:86:THR:HG22	1:C:90:MET:HE2	1.53	0.88
1:C:87:GLN:HA	1:C:90:MET:HE3	1.61	0.83
1:A:160:LYS:H	1:A:160:LYS:HE2	1.44	0.79
1:D:156:HIS:HA	1:D:164:ASP:OD1	1.87	0.75

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	534/543 (98%)	518 (97%)	16 (3%)	0	100	100
1	B	534/543 (98%)	514 (96%)	20 (4%)	0	100	100
1	C	534/543 (98%)	517 (97%)	17 (3%)	0	100	100
1	D	534/543 (98%)	511 (96%)	22 (4%)	1 (0%)	43	51

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
All	All	2136/2172 (98%)	2060 (96%)	75 (4%)	1 (0%)	100	100

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	272	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	A	470/477 (98%)	469 (100%)	1 (0%)	87	94
1	B	470/477 (98%)	469 (100%)	1 (0%)	87	94
1	C	470/477 (98%)	469 (100%)	1 (0%)	87	94
1	D	470/477 (98%)	469 (100%)	1 (0%)	87	94
All	All	1880/1908 (98%)	1876 (100%)	4 (0%)	87	94

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

Mol	Chain	Res	Type
1	A	310	ASN
1	B	310	ASN
1	C	310	ASN
1	D	310	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	206	HIS
1	D	382	ASN
1	B	412	ASN
1	B	435	GLN
1	C	117	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 ⓘ

8 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	BGC	E	1	2	12,12,12	0.47	0	17,17,17	0.77	0
2	GLC	E	2	2	11,11,12	1.81	2 (18%)	15,15,17	1.99	4 (26%)
2	BGC	F	1	2	12,12,12	0.45	0	17,17,17	0.93	0
2	GLC	F	2	2	11,11,12	1.78	3 (27%)	15,15,17	1.67	4 (26%)
2	BGC	G	1	2	12,12,12	0.46	0	17,17,17	1.10	2 (11%)
2	GLC	G	2	2	11,11,12	1.45	2 (18%)	15,15,17	1.80	3 (20%)
2	BGC	H	1	2	12,12,12	0.51	0	17,17,17	1.22	2 (11%)
2	GLC	H	2	2	11,11,12	1.76	3 (27%)	15,15,17	1.95	4 (26%)

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
2	BGC	E	1	2	-	2/2/22/22	0/1/1/1
2	GLC	E	2	2	-	1/2/19/22	0/1/1/1
2	BGC	F	1	2	-	2/2/22/22	0/1/1/1
2	GLC	F	2	2	-	2/2/19/22	0/1/1/1
2	BGC	G	1	2	-	2/2/22/22	0/1/1/1

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	GLC	G	2	2	-	1/2/19/22	0/1/1/1
2	BGC	H	1	2	-	2/2/22/22	0/1/1/1
2	GLC	H	2	2	-	0/2/19/22	0/1/1/1

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	E	2	GLC	O5-C1	4.59	1.51	1.43
2	H	2	GLC	O5-C1	4.20	1.50	1.43
2	F	2	GLC	O5-C1	3.82	1.49	1.43
2	G	2	GLC	O5-C1	3.20	1.48	1.43
2	F	2	GLC	C2-C3	-3.15	1.47	1.52

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	H	2	GLC	C1-C2-C3	-4.22	104.48	109.67
2	E	2	GLC	O5-C1-C2	-4.13	104.40	110.77
2	E	2	GLC	O2-C2-C3	3.86	117.87	110.14
2	H	2	GLC	O5-C1-C2	-3.65	105.13	110.77
2	G	2	GLC	C1-C2-C3	-3.47	105.40	109.67

There are no chirality outliers.

5 of 12 torsion outliers are listed below:

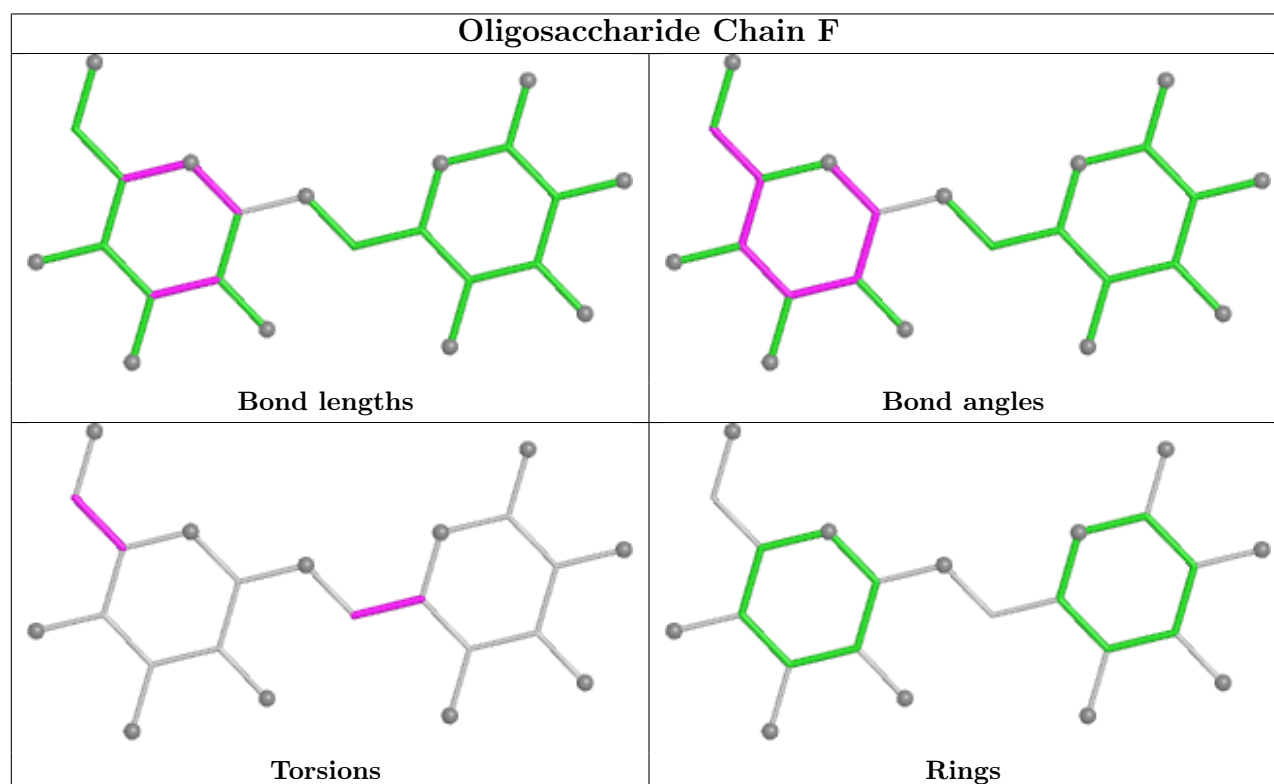
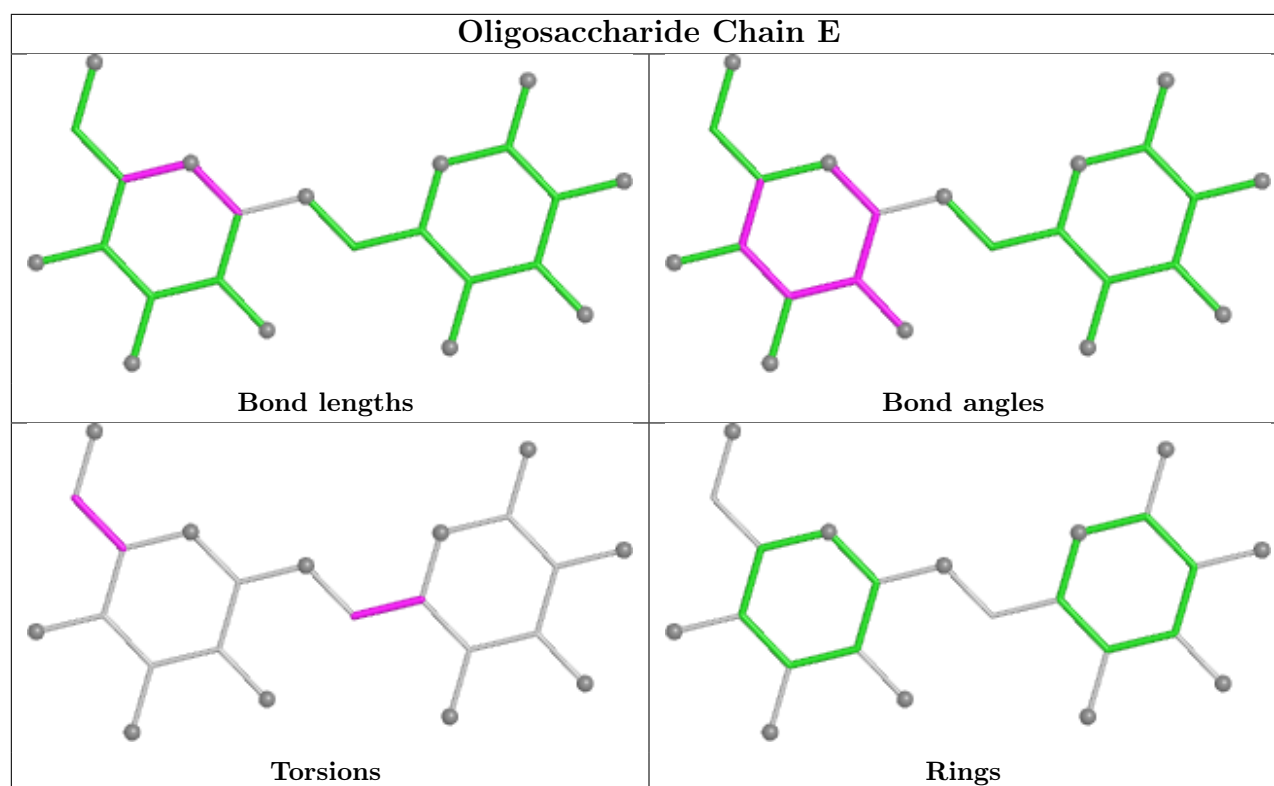
Mol	Chain	Res	Type	Atoms
2	F	1	BGC	C4-C5-C6-O6
2	F	1	BGC	O5-C5-C6-O6
2	H	1	BGC	C4-C5-C6-O6
2	F	2	GLC	C4-C5-C6-O6
2	G	1	BGC	C4-C5-C6-O6

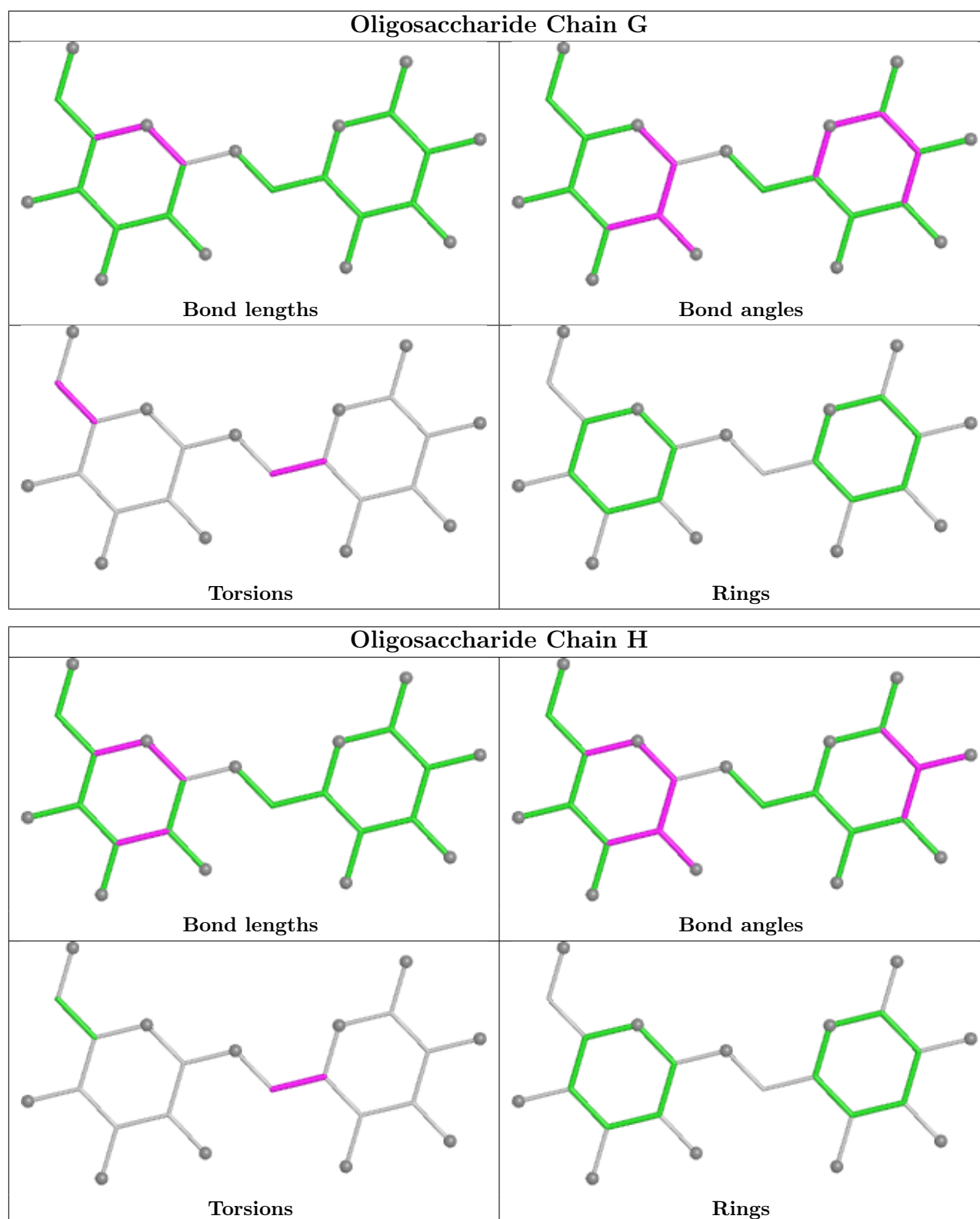
There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	F	1	BGC	1	0

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





5.6 Ligand geometry [i](#)

Of 8 ligands modelled in this entry, 8 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	536/543 (98%)	-1.50	0 100 100	17, 25, 41, 61	0
1	B	536/543 (98%)	-1.51	0 100 100	17, 26, 40, 59	0
1	C	536/543 (98%)	-1.53	0 100 100	16, 24, 38, 64	0
1	D	536/543 (98%)	-1.52	0 100 100	16, 24, 38, 61	0
All	All	2144/2172 (98%)	-1.52	0 100 100	16, 25, 40, 64	0

There are no RSRZ outliers to report.

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

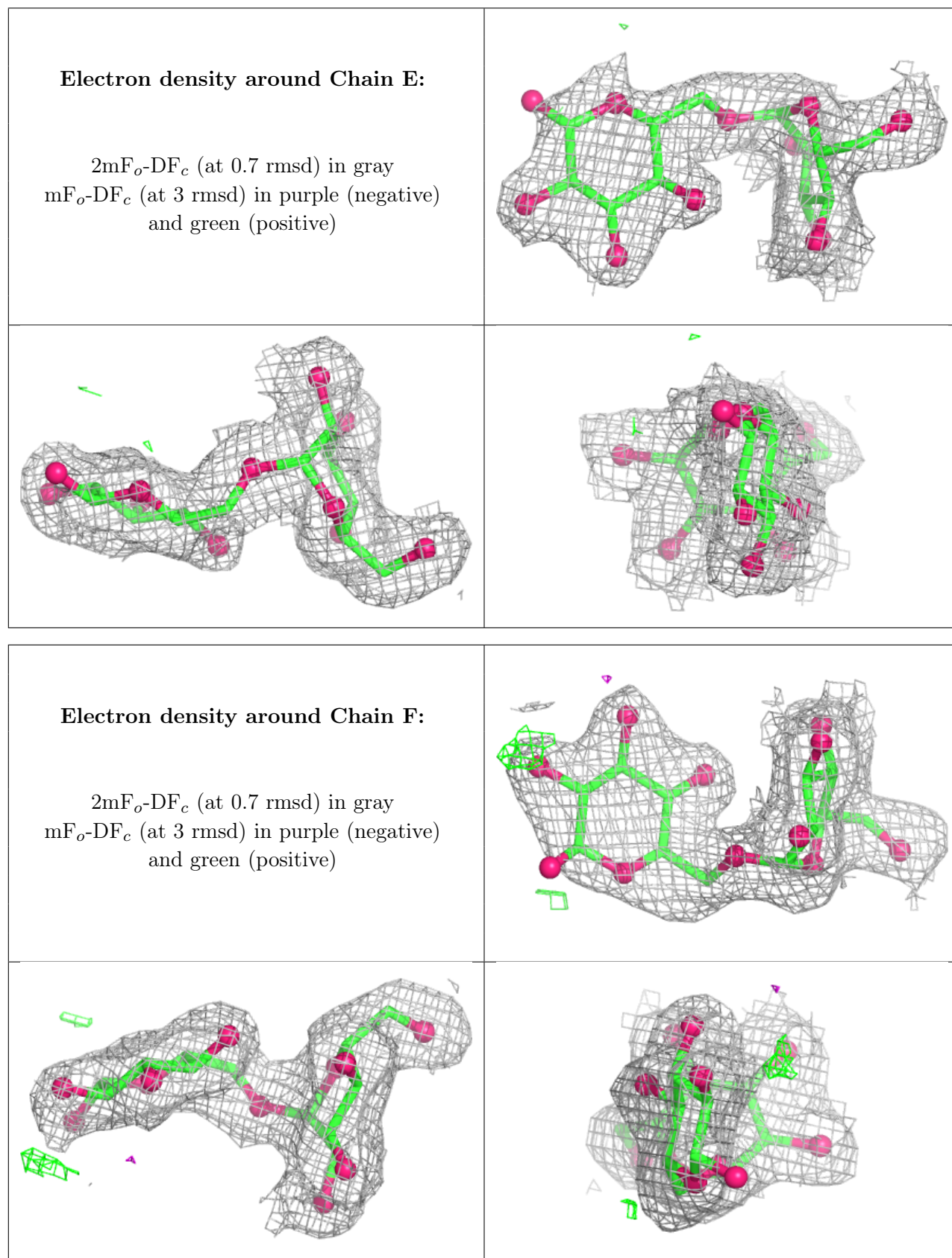
There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

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.

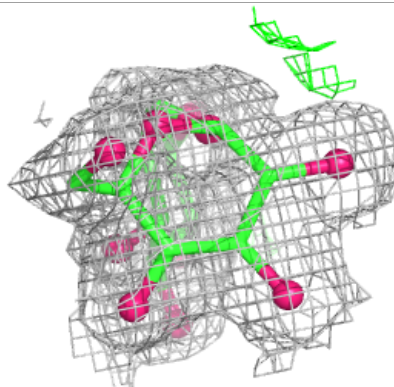
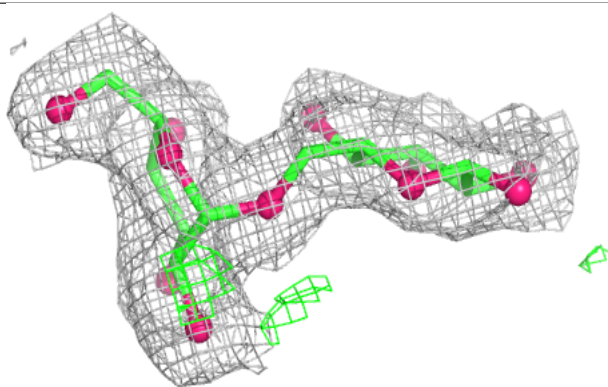
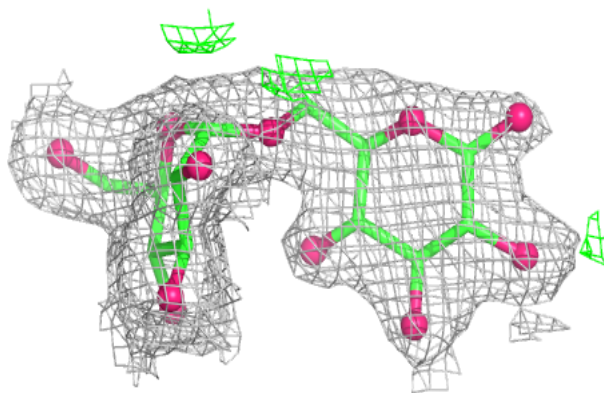
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	BGC	E	1	12/12	0.99	0.04	29,39,50,60	0
2	GLC	E	2	11/12	0.99	0.03	18,25,33,33	0
2	BGC	F	1	12/12	0.99	0.04	28,32,41,49	0
2	GLC	F	2	11/12	0.99	0.02	19,23,26,26	0
2	BGC	G	1	12/12	0.99	0.04	24,31,39,48	0
2	BGC	H	1	12/12	0.99	0.04	27,34,44,49	0
2	GLC	H	2	11/12	0.99	0.03	17,22,26,29	0
2	GLC	G	2	11/12	1.00	0.02	18,23,25,26	0

The following is a graphical depiction of the model fit to experimental electron density for oligosaccharide. Each fit is shown from different orientation to approximate a three-dimensional view.

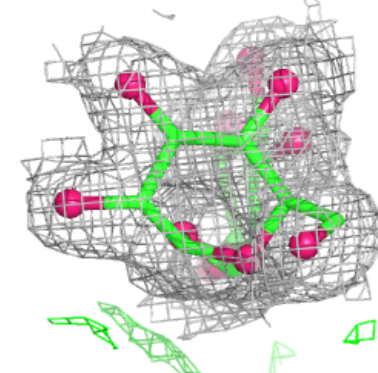
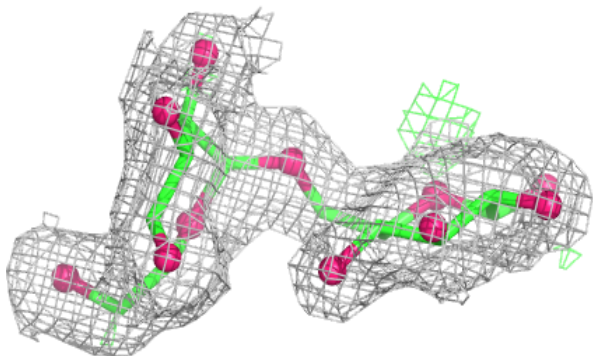
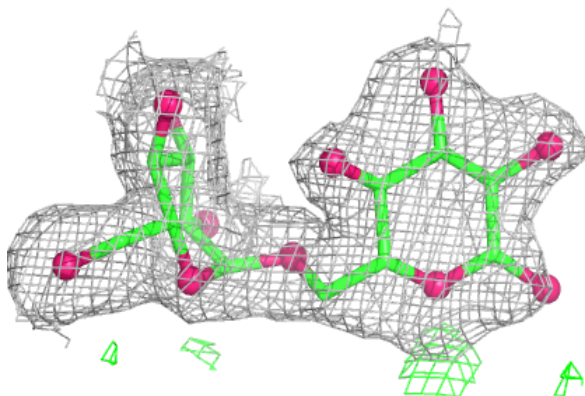


Electron density around Chain G:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

**Electron density around Chain H:**

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



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
3	CA	A	601	1/1	0.99	0.02	28,28,28,28	0
3	CA	A	602	1/1	0.99	0.02	34,34,34,34	0
3	CA	C	602	1/1	0.99	0.02	34,34,34,34	0
3	CA	D	601	1/1	0.99	0.02	26,26,26,26	0
3	CA	D	602	1/1	0.99	0.03	38,38,38,38	0
3	CA	B	601	1/1	1.00	0.02	26,26,26,26	0
3	CA	B	602	1/1	1.00	0.02	33,33,33,33	0
3	CA	C	601	1/1	1.00	0.01	26,26,26,26	0

6.5 Other polymers [i](#)

There are no such residues in this entry.