Full wwPDB EM Validation Report (i)

Jul 9, 2025 – 12:59 PM JST

PDB ID	:	8ZYA / pdb_00008zya
EMDB ID	:	EMD-60560
Title	:	Ra9479 Bat ACE2 Bound to BtkY72 Sarbecovirus Spike RBD (Focused Refinement)
Authors	:	Wang, J.; Xiong, X.
Deposited on	:	2024-06-16
Resolution	:	2.50 Å(reported)

This is a Full wwPDB EM 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/EMValidationReportHelp
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 (1)) were used in the production of this report:

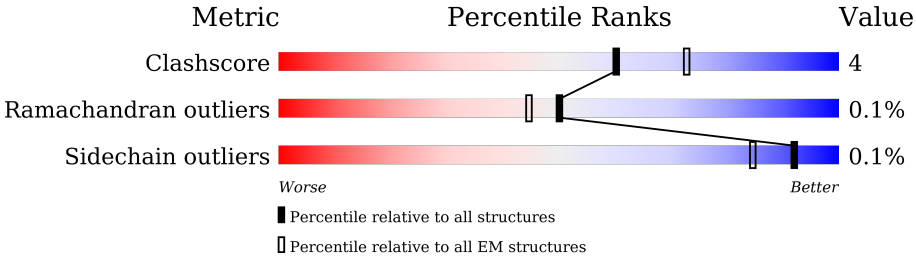
EMDB validation analysis	:	FAILED
Mogul	:	1.8.5 (274361), CSD as541be (2020)
MolProbity	:	4-5-2 with Phenix2.0rc1
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ	:	FAILED
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.44

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 2.50 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)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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%

Mol	Chain	Length	Quality of chain
1	A	218	77% 8% 15%
2	D	804	75% 11% 13%
3	B	2	50% 50%
3	C	2	100%
3	E	2	50% 50%

2 Entry composition (i)

There are 4 unique types of molecules in this entry. The entry contains 7306 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Spike glycoprotein.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	186	1464	943	237	277	7	0	0

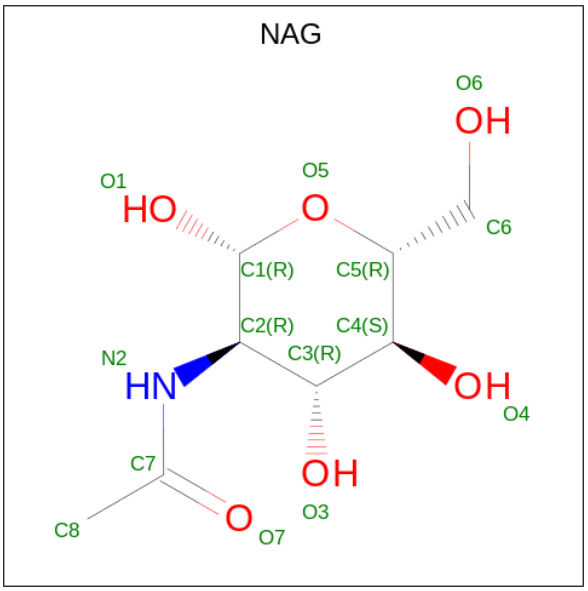
- Molecule 2 is a protein called Angiotensin-converting enzyme.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	D	698	5730	3656	966	1075	33	0	0

- Molecule 3 is an oligosaccharide called 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
3	B	2	28	16	2	10	0	0
3	C	2	28	16	2	10	0	0
3	E	2	28	16	2	10	0	0

- Molecule 4 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: $C_8H_{15}NO_6$) (labeled as "Ligand of Interest" by depositor).



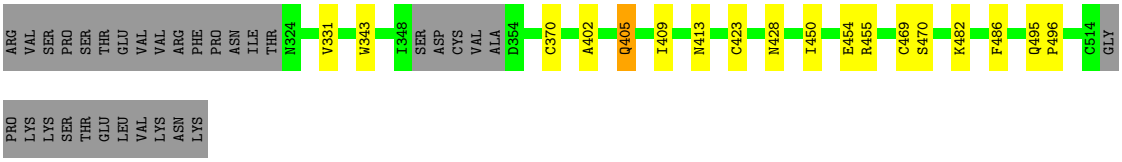
Mol	Chain	Residues	Atoms				AltConf
			Total	C	N	O	
4	D	1	14	8	1	5	0
			Total	C	N	O	
4	D	1	14	8	1	5	0

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.

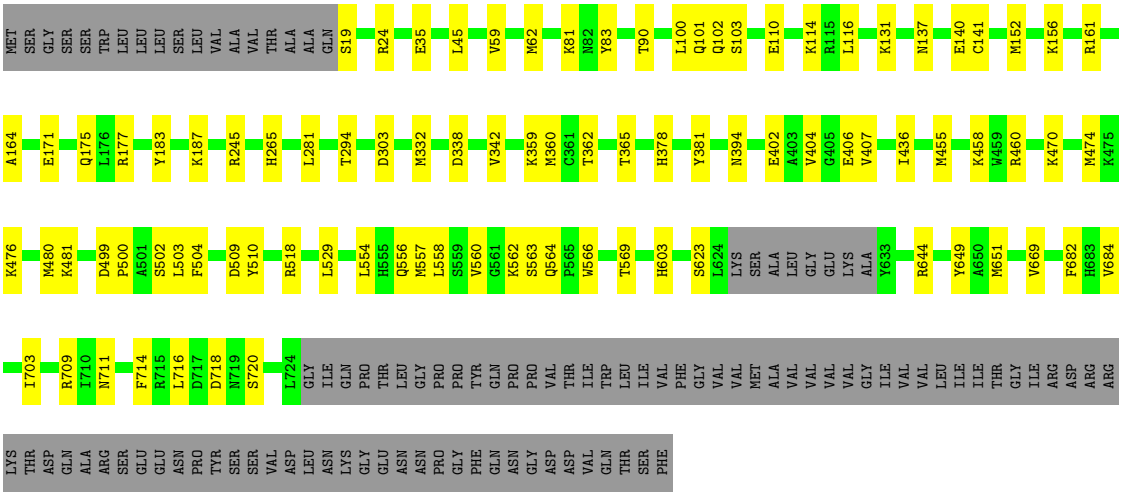
• Molecule 1: Spike glycoprotein

Chain A: 77% 8% 15%



• Molecule 2: Angiotensin-converting enzyme

Chain D: 75% 11% 13%



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

Chain B: 50% 50%

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

Chain C: 100%

NAG1
NAG2

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

Chain E: 50% 50%

NAG1
NAG2

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	931804	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TITAN	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	50	Depositor
Minimum defocus (nm)	800	Depositor
Maximum defocus (nm)	2400	Depositor
Magnification	Not provided	
Image detector	GATAN K3 (6k x 4k)	Depositor

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: NAG

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	0.13	0/1505	0.39	1/2050 (0.0%)
2	D	0.19	0/5891	0.43	2/7989 (0.0%)
All	All	0.18	0/7396	0.43	3/10039 (0.0%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	331	VAL	N-CA-C	-7.52	106.57	113.71
2	D	90	THR	CA-C-N	5.55	124.77	120.33
2	D	90	THR	C-N-CA	5.55	124.77	120.33

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	1464	0	1392	9	0
2	D	5730	0	5484	52	0
3	B	28	0	25	0	0
3	C	28	0	25	1	0
3	E	28	0	25	0	0
4	D	28	0	26	1	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	7306	0	6977	61	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.

All (61) 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)
2:D:406:GLU:HG3	2:D:518:ARG:HD3	1.82	0.61
2:D:332:MET:HE1	2:D:342:VAL:HG11	1.86	0.58
2:D:83:TYR:O	2:D:101:GLN:NE2	2.38	0.57
2:D:394:ASN:HB3	2:D:562:LYS:HD2	1.89	0.55
2:D:116:LEU:HD21	2:D:187:LYS:HE2	1.87	0.55
2:D:360:MET:HE2	2:D:362:THR:HB	1.89	0.55
2:D:378:HIS:HE1	2:D:402:GLU:HA	1.72	0.55
2:D:131:LYS:HE2	2:D:141:CYS:HB2	1.87	0.55
1:A:482:LYS:NZ	2:D:35:GLU:OE2	2.41	0.54
1:A:370:CYS:HA	1:A:423:CYS:HA	1.89	0.53
2:D:458:LYS:HB3	2:D:480:MET:HE1	1.91	0.53
1:A:409:ILE:HA	1:A:413:ASN:HB2	1.90	0.53
2:D:716:LEU:HD13	2:D:720:SER:HB3	1.91	0.52
2:D:137:ASN:ND2	2:D:140:GLU:OE1	2.40	0.51
2:D:474:MET:HE1	2:D:500:PRO:HD2	1.92	0.51
1:A:402:ALA:HB3	1:A:405:GLN:HG3	1.91	0.51
1:A:343:TRP:O	1:A:455:ARG:NH1	2.44	0.51
2:D:381:TYR:HD1	2:D:558:LEU:HD22	1.75	0.51
2:D:81:LYS:NZ	2:D:103:SER:OG	2.36	0.51
2:D:402:GLU:HB3	2:D:518:ARG:HG3	1.93	0.51
2:D:499:ASP:O	2:D:502:SER:OG	2.29	0.50
2:D:171:GLU:O	2:D:175:GLN:NE2	2.39	0.50
2:D:110:GLU:HG3	2:D:114:LYS:HE2	1.93	0.50
2:D:651:MET:HG3	2:D:684:VAL:HG11	1.94	0.49
2:D:59:VAL:HA	2:D:62:MET:HE1	1.93	0.48
2:D:623:SER:HB2	2:D:720:SER:HA	1.95	0.48
2:D:503:LEU:HD12	2:D:504:PHE:H	1.77	0.48
2:D:177:ARG:NH2	2:D:470:LYS:O	2.47	0.47
2:D:338:ASP:OD1	2:D:338:ASP:N	2.44	0.47
2:D:152:MET:HE3	2:D:164:ALA:HB3	1.96	0.47
2:D:529:LEU:HD11	2:D:554:LEU:HD13	1.96	0.47
2:D:649:TYR:OH	2:D:709:ARG:NH2	2.46	0.47
2:D:303:ASP:N	2:D:303:ASP:OD1	2.47	0.47

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:455:MET:HE2	2:D:481:LYS:HD3	1.97	0.47
2:D:562:LYS:C	2:D:564:GLN:H	2.22	0.46
2:D:682:PHE:HZ	2:D:703:ILE:HD11	1.82	0.45
2:D:566:TRP:HA	2:D:569:THR:HG22	1.98	0.45
2:D:718:ASP:OD1	2:D:718:ASP:N	2.48	0.45
2:D:556:GLN:O	2:D:556:GLN:HG2	2.17	0.44
1:A:428:ASN:ND2	1:A:495:GLN:OE1	2.42	0.44
2:D:156:LYS:HD3	2:D:281:LEU:HD21	2.00	0.44
2:D:183:TYR:OH	2:D:509:ASP:OD1	2.32	0.44
2:D:100:LEU:O	2:D:102:GLN:N	2.51	0.44
2:D:711:ASN:HA	2:D:714:PHE:HD2	1.83	0.43
2:D:19:SER:O	2:D:24:ARG:NH1	2.44	0.43
2:D:404:VAL:HA	2:D:407:VAL:HG12	2.00	0.43
1:A:450:ILE:HG12	1:A:454:GLU:HB3	2.00	0.43
2:D:644:ARG:NH1	2:D:669:VAL:O	2.43	0.43
2:D:245:ARG:NH2	2:D:603:HIS:O	2.53	0.42
1:A:469:CYS:SG	1:A:470:SER:N	2.93	0.42
2:D:332:MET:HE2	2:D:359:LYS:HG2	2.00	0.42
2:D:294:THR:HG23	2:D:365:THR:HA	2.01	0.42
1:A:486:PHE:CG	1:A:496:PRO:HG3	2.55	0.42
2:D:436:ILE:HG13	4:D:902:NAG:H81	2.02	0.41
2:D:460:ARG:NH2	2:D:510:TYR:O	2.49	0.41
2:D:557:MET:O	2:D:560:VAL:HG22	2.20	0.41
2:D:161:ARG:NE	2:D:265:HIS:O	2.42	0.41
2:D:476:LYS:HA	2:D:476:LYS:HD3	1.75	0.40
2:D:476:LYS:O	2:D:480:MET:HG2	2.22	0.40
2:D:45:LEU:HD23	2:D:45:LEU:HA	1.97	0.40
3:C:1:NAG:O3	3:C:2:NAG:N2	2.54	0.40

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 PDB entries followed by that with respect to all EM entries.

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	182/218 (84%)	170 (93%)	12 (7%)	0	100	100
2	D	694/804 (86%)	666 (96%)	27 (4%)	1 (0%)	48	69
All	All	876/1022 (86%)	836 (95%)	39 (4%)	1 (0%)	50	69

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	D	563	SER

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 PDB entries followed by that with respect to all EM entries.

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	162/192 (84%)	161 (99%)	1 (1%)	84	94
2	D	627/716 (88%)	627 (100%)	0	100	100
All	All	789/908 (87%)	788 (100%)	1 (0%)	92	97

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	405	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	405	GLN
2	D	221	GLN
2	D	329	ASN
2	D	374	HIS
2	D	401	HIS
2	D	599	ASN
2	D	719	ASN

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)

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	$\#\|Z\| > 2$
3	NAG	B	1	3,2	14,14,15	0.30	0	17,19,21	0.63	1 (5%)
3	NAG	B	2	3	14,14,15	0.30	0	17,19,21	0.43	0
3	NAG	C	1	3,2	14,14,15	0.36	0	17,19,21	0.87	1 (5%)
3	NAG	C	2	3	14,14,15	0.70	1 (7%)	17,19,21	0.84	1 (5%)
3	NAG	E	1	3,2	14,14,15	0.23	0	17,19,21	0.46	0
3	NAG	E	2	3	14,14,15	0.68	1 (7%)	17,19,21	1.96	2 (11%)

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	NAG	B	1	3,2	-	2/6/23/26	0/1/1/1
3	NAG	B	2	3	-	2/6/23/26	0/1/1/1
3	NAG	C	1	3,2	-	3/6/23/26	0/1/1/1
3	NAG	C	2	3	-	3/6/23/26	0/1/1/1
3	NAG	E	1	3,2	-	2/6/23/26	0/1/1/1
3	NAG	E	2	3	-	3/6/23/26	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	2	NAG	C1-C2	2.08	1.55	1.52
3	E	2	NAG	C1-C2	2.00	1.55	1.52

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	E	2	NAG	C2-N2-C7	6.91	132.75	122.90
3	E	2	NAG	C1-C2-N2	3.21	115.97	110.49
3	C	1	NAG	C2-N2-C7	2.48	126.44	122.90
3	C	2	NAG	C2-N2-C7	2.42	126.35	122.90
3	B	1	NAG	C1-O5-C5	2.14	115.09	112.19

There are no chirality outliers.

All (15) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	2	NAG	O5-C5-C6-O6
3	C	2	NAG	O5-C5-C6-O6
3	E	1	NAG	O5-C5-C6-O6
3	E	2	NAG	C8-C7-N2-C2
3	E	2	NAG	O7-C7-N2-C2
3	E	1	NAG	C4-C5-C6-O6
3	C	2	NAG	C4-C5-C6-O6
3	C	1	NAG	O5-C5-C6-O6
3	C	1	NAG	C4-C5-C6-O6
3	B	2	NAG	C4-C5-C6-O6
3	B	1	NAG	O5-C5-C6-O6
3	C	1	NAG	C3-C2-N2-C7
3	E	2	NAG	C3-C2-N2-C7
3	B	1	NAG	C4-C5-C6-O6
3	C	2	NAG	C3-C2-N2-C7

There are no ring outliers.

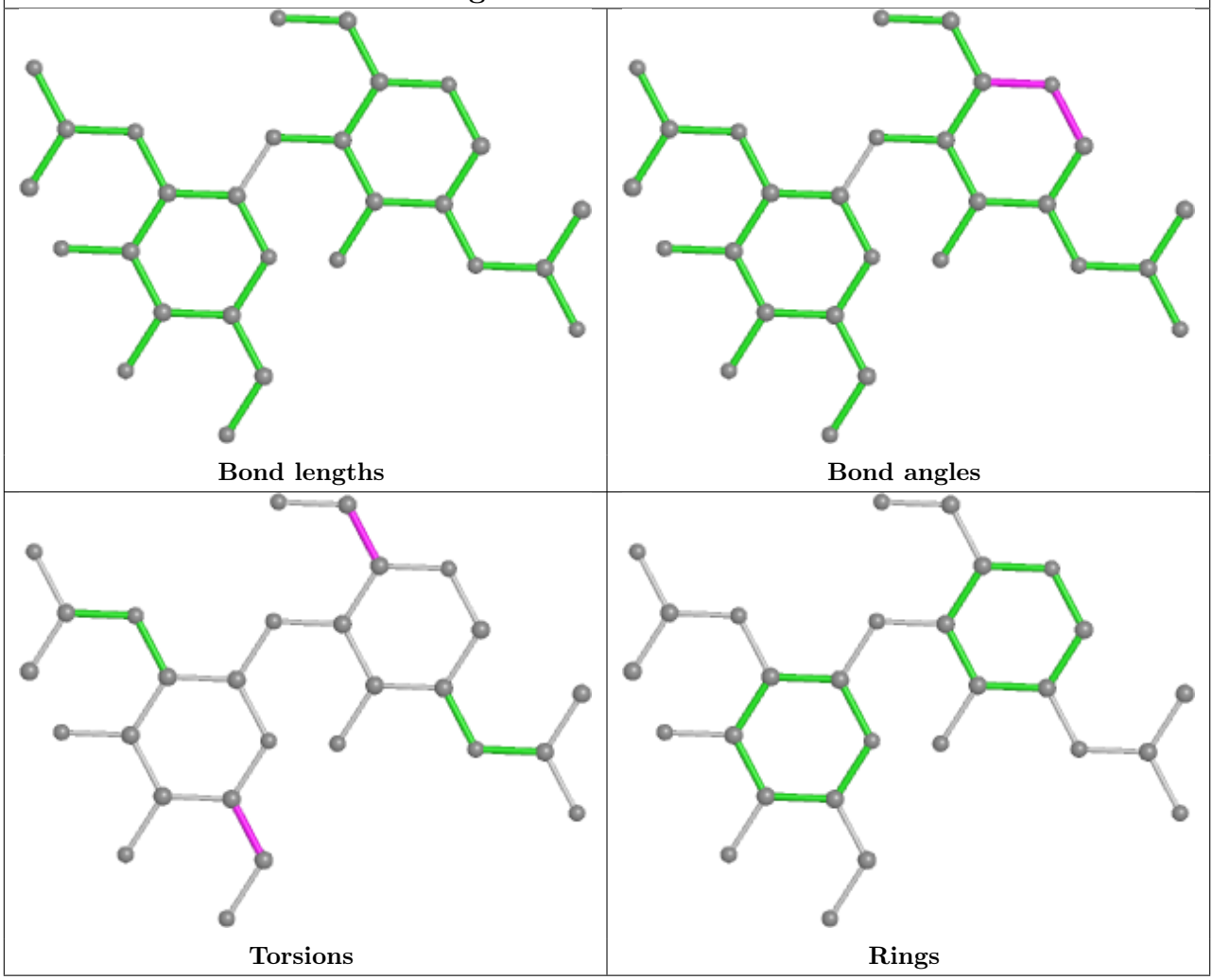
2 monomers are involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	C	2	NAG	1	0
3	C	1	NAG	1	0

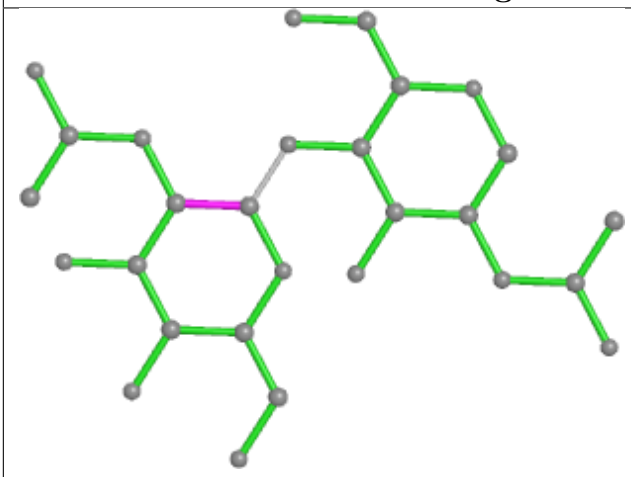
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths,

bond angles, torsion angles, and ring geometry for oligosaccharide.

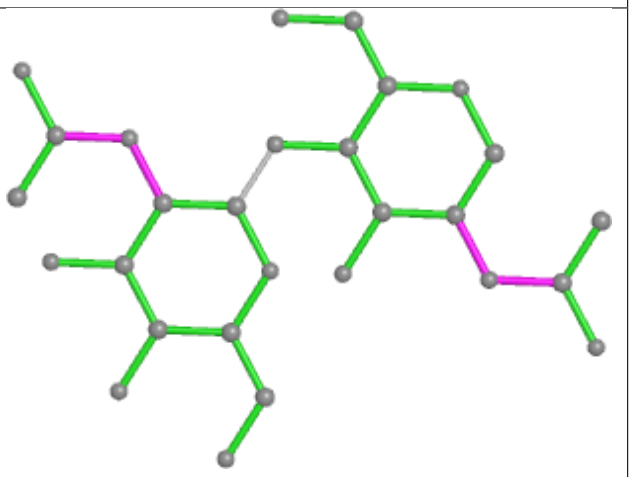
Oligosaccharide Chain B



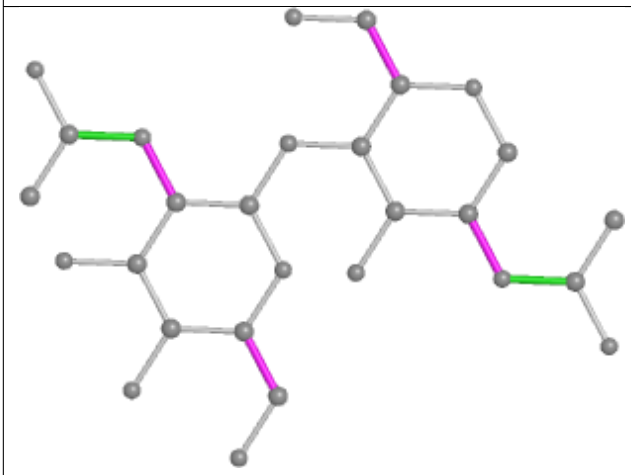
Oligosaccharide Chain C



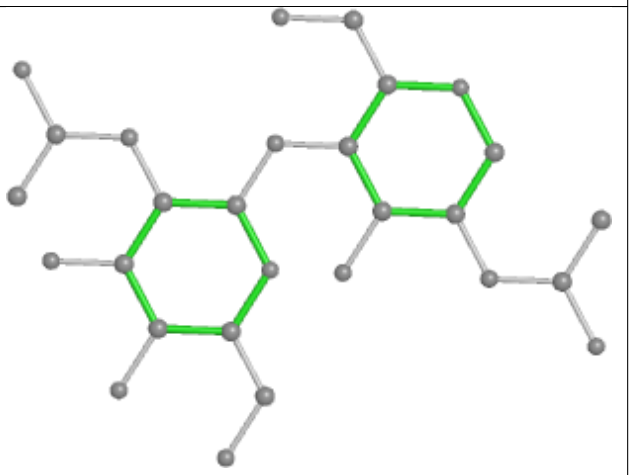
Bond lengths



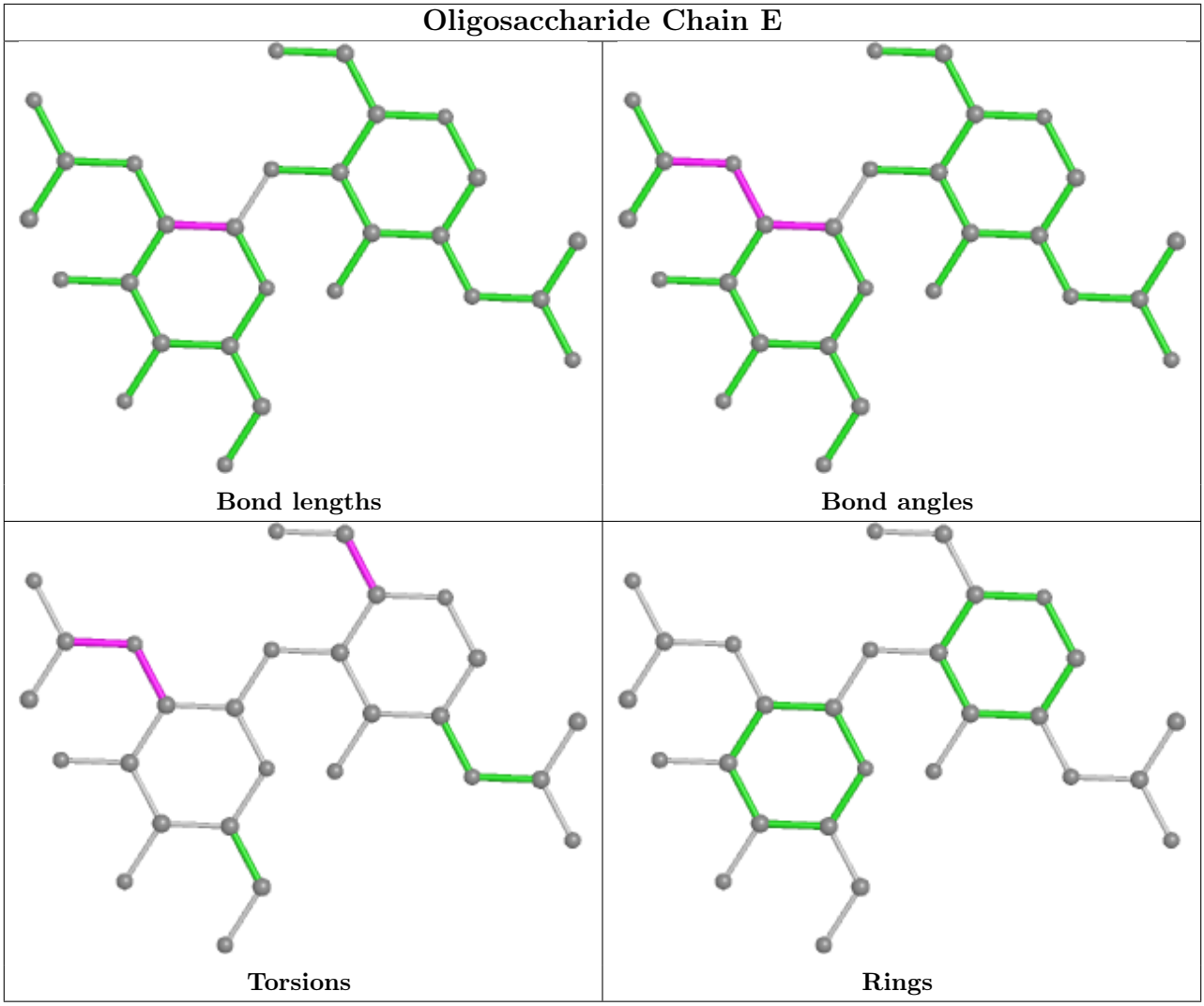
Bond angles



Torsions



Rings



5.6 Ligand geometry (i)

2 ligands 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	$\#\|Z\| > 2$
4	NAG	D	901	2	14,14,15	0.32	0	17,19,21	0.53	0
4	NAG	D	902	2	14,14,15	0.31	0	17,19,21	0.50	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	NAG	D	901	2	-	2/6/23/26	0/1/1/1
4	NAG	D	902	2	-	2/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

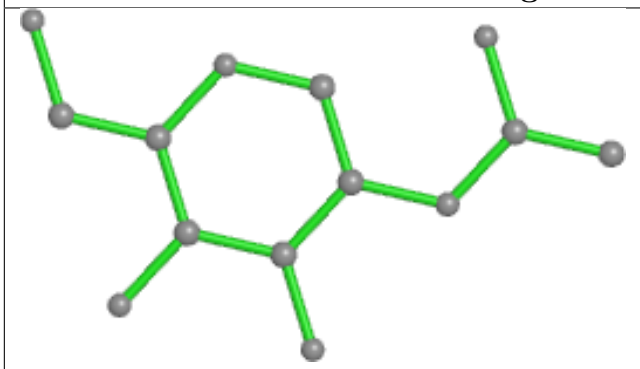
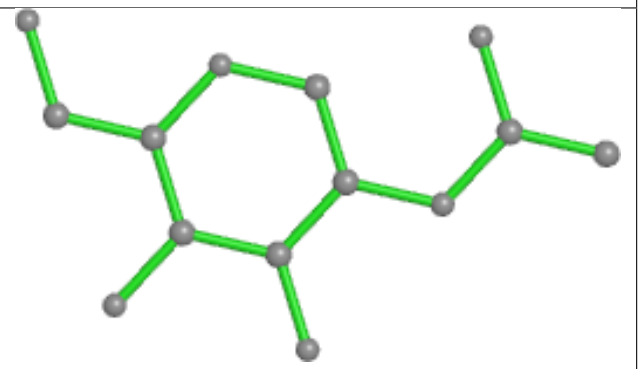
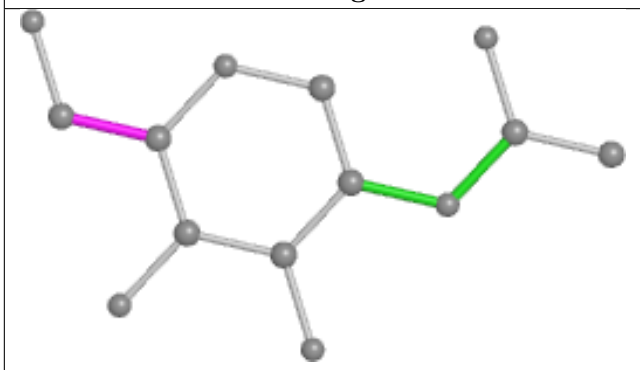
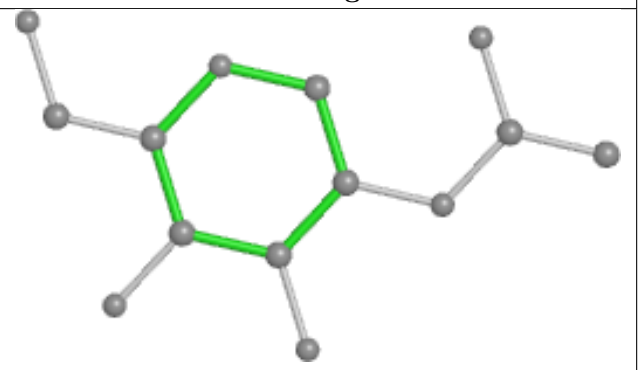
Mol	Chain	Res	Type	Atoms
4	D	901	NAG	O5-C5-C6-O6
4	D	901	NAG	C4-C5-C6-O6
4	D	902	NAG	O5-C5-C6-O6
4	D	902	NAG	C4-C5-C6-O6

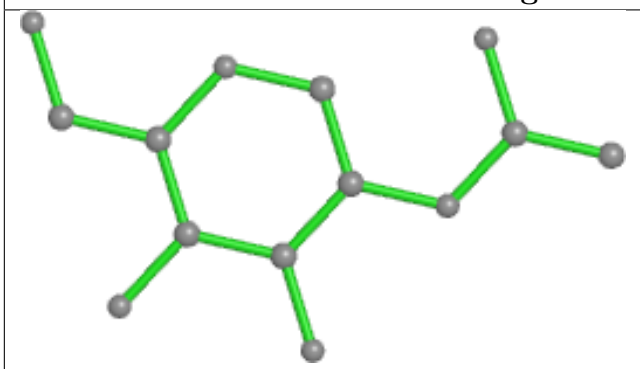
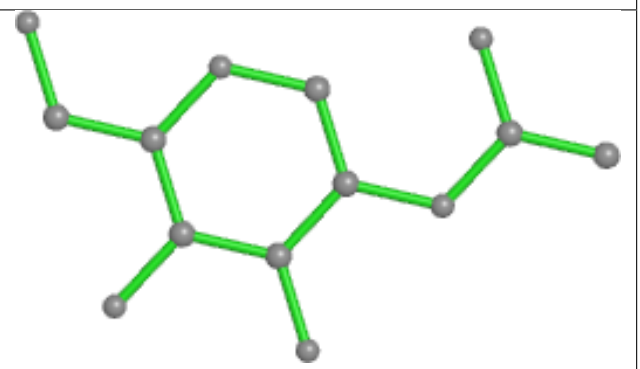
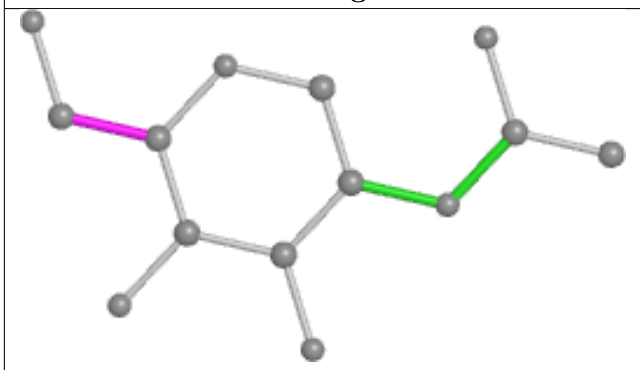
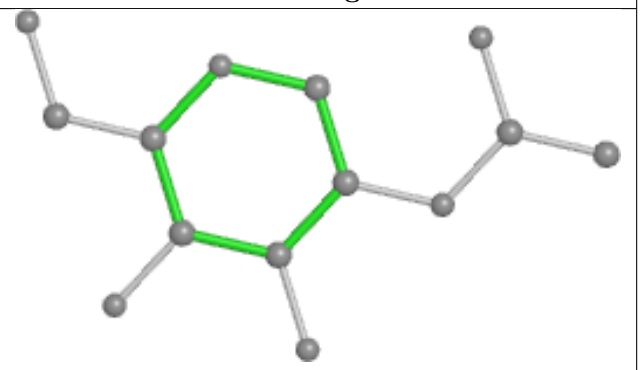
There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	D	902	NAG	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 all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand NAG D 901	
 Bond lengths	 Bond angles
 Torsions	 Rings

Ligand NAG D 902	
 Bond lengths	 Bond angles
 Torsions	 Rings

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.