



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 12:35 PM UTC

PDB ID : 1APU / pdb_00001apu
Title : Crystallographic analysis of a pepstatin analogue binding to the aspartyl proteinase penicillopepsin at 1.8 angstroms resolution
Authors : Sielecki, A.R.; James, M.N.G.
Deposited on : 1991-12-16
Resolution : 1.80 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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

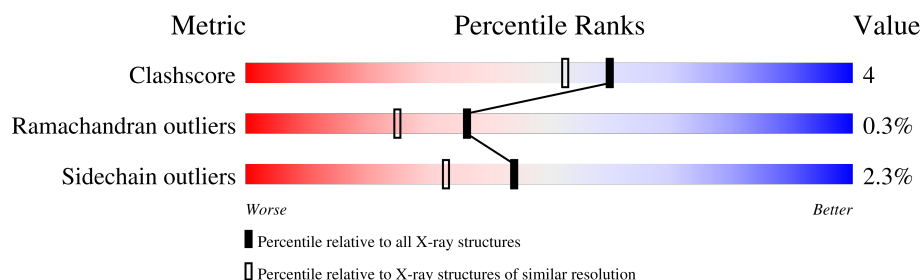
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	E	323	 69% 29% ..
2	I	4	 50% 25% 25%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2726 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.

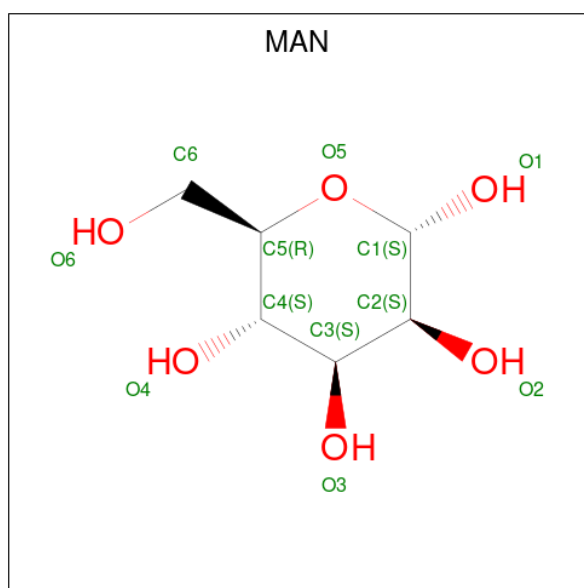
- Molecule 1 is a protein called PROTEIN (PENICILLOPEPSIN).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	E	323	2366	1479	377	508	2	0	0	0

- Molecule 2 is a protein called PEPSTATIN ANALOGUE ISOVALERYL-VAL-VAL-STA-O-ET.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
			Total	C	N	O			
2	I	4	34	25	3	6	0	0	0

- Molecule 3 is alpha-D-mannopyranose (CCD ID: MAN) (formula: $C_6H_{12}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	I	1	11	6	5	0	0

- Molecule 4 is water.

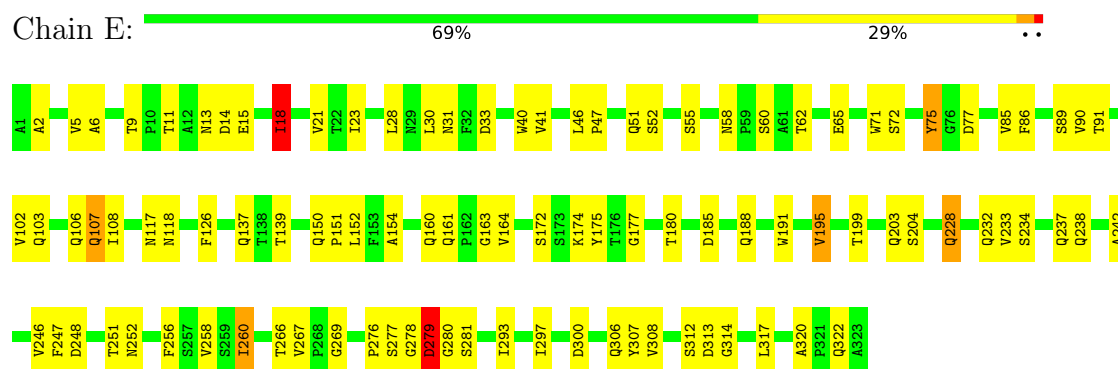
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	E	311	Total 311	O 311	0	0
4	I	4	Total 4	O 4	0	0

3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

Note EDS was not executed.

• Molecule 1: PROTEIN (PENICILLOPEPSIN)



• Molecule 2: PEPSTATIN ANALOGUE ISOVALERYL-VAL-VAL-STA-O-ET



4 Data and refinement statistics

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

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	97.24Å 46.50Å 65.65Å 90.00° 115.34° 90.00°	Depositor
Resolution (Å)	8.00 – 1.80	Depositor
% Data completeness (in resolution range)	(Not available) (8.00-1.80)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, R_{free}	0.131 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2726	wwPDB-VP
Average B, all atoms (Å ²)	14.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: IVA, MAN, 32L

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	E	1.28	3/2420 (0.1%)	2.05	87/3304 (2.6%)
2	I	0.94	0/13	2.06	0/17
All	All	1.27	3/2433 (0.1%)	2.05	87/3321 (2.6%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	E	62	THR	CA-CB	5.46	1.62	1.54
1	E	31	ASN	N-CA	5.30	1.52	1.46
1	E	320	ALA	N-CA	5.05	1.51	1.46

All (87) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	279	ASP	CA-CB-CG	9.66	122.27	112.60
1	E	13	ASN	OD1-CG-ND2	9.10	131.70	122.60
1	E	14	ASP	CA-CB-CG	8.81	121.41	112.60
1	E	58	ASN	CB-CA-C	8.12	118.61	110.33
1	E	6	ALA	CA-C-O	-7.18	113.10	120.71
1	E	293	ILE	CA-C-O	-6.93	110.84	119.43
1	E	297	ILE	O-C-N	6.91	132.30	122.62
1	E	237	GLN	CB-CG-CD	6.88	124.29	112.60
1	E	65	GLU	CA-C-O	-6.67	113.69	121.16
1	E	161	GLN	O-C-N	6.65	126.50	121.85
1	E	150	GLN	O-C-N	6.50	128.76	121.94
1	E	246	VAL	O-C-N	6.50	130.25	123.04
1	E	150	GLN	CA-C-O	-6.45	113.06	120.03
1	E	238	GLN	OE1-CD-NE2	6.44	129.04	122.60
1	E	55	SER	N-CA-C	-6.41	98.81	109.46
1	E	15	GLU	CB-CG-CD	-6.37	101.78	112.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	23	ILE	O-C-N	6.30	129.88	123.20
1	E	86	PHE	CA-CB-CG	-6.19	107.61	113.80
1	E	248	ASP	CA-C-O	-6.18	113.87	120.92
1	E	164	VAL	O-C-N	6.16	129.98	123.02
1	E	118	ASN	OD1-CG-ND2	-6.14	116.46	122.60
1	E	276	PRO	O-C-N	6.13	130.06	123.01
1	E	137	GLN	OE1-CD-NE2	6.09	128.69	122.60
1	E	300	ASP	O-C-N	6.01	128.49	122.12
1	E	297	ILE	CA-C-O	-6.00	112.87	120.86
1	E	281	SER	N-CA-C	5.92	120.02	113.21
1	E	108	ILE	CA-C-O	-5.91	115.02	121.28
1	E	62	THR	N-CA-CB	-5.87	103.23	110.98
1	E	267	VAL	O-C-N	5.86	125.06	121.37
1	E	154	ALA	O-C-N	5.84	130.24	123.17
1	E	21	VAL	CA-C-O	-5.74	114.18	120.43
1	E	308	VAL	O-C-N	5.70	129.42	123.26
1	E	30	LEU	O-C-N	5.65	130.39	123.10
1	E	258	VAL	O-C-N	5.64	129.03	123.00
1	E	60	SER	CA-CB-OG	-5.62	99.85	111.10
1	E	269	GLY	CA-C-O	-5.62	114.72	120.45
1	E	188	GLN	OE1-CD-NE2	5.62	128.22	122.60
1	E	313	ASP	CA-C-O	-5.62	114.25	120.60
1	E	91	THR	CA-C-N	-5.59	115.05	122.98
1	E	91	THR	C-N-CA	-5.59	115.05	122.98
1	E	160	GLN	CG-CD-NE2	5.57	124.75	116.40
1	E	191	TRP	O-C-N	5.55	129.07	122.46
1	E	2	ALA	CA-C-O	5.53	128.25	121.56
1	E	260	ILE	O-C-N	5.53	128.91	122.99
1	E	5	VAL	CA-C-O	-5.47	114.64	120.39
1	E	174	LYS	CG-CD-CE	5.47	123.87	111.30
1	E	89	SER	O-C-N	5.46	129.44	123.27
1	E	102	VAL	O-C-N	5.42	128.95	123.20
1	E	204	SER	CA-C-O	-5.42	115.01	121.56
1	E	9	THR	O-C-N	5.40	128.17	121.79
1	E	154	ALA	CA-C-O	-5.38	115.32	121.40
1	E	13	ASN	CA-C-O	-5.38	113.98	120.32
1	E	280	GLY	CA-C-N	5.36	133.44	122.55
1	E	280	GLY	C-N-CA	5.36	133.44	122.55
1	E	33	ASP	N-CA-CB	-5.36	102.14	110.87
1	E	228	GLN	CA-CB-CG	5.35	124.80	114.10
1	E	195	VAL	O-C-N	5.34	128.58	123.14
1	E	307	TYR	N-CA-C	-5.33	99.83	108.52

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	31	ASN	N-CA-CB	-5.32	101.74	110.42
1	E	75	TYR	CA-C-N	5.31	126.78	120.14
1	E	75	TYR	C-N-CA	5.31	126.78	120.14
1	E	11	THR	CA-CB-OG1	-5.29	101.67	109.60
1	E	60	SER	O-C-N	5.28	127.72	122.12
1	E	199	THR	CA-CB-OG1	-5.28	101.69	109.60
1	E	41	VAL	O-C-N	5.26	128.96	123.02
1	E	256	PHE	CA-C-O	-5.25	114.50	120.32
1	E	163	GLY	CA-C-N	-5.25	115.24	122.69
1	E	163	GLY	C-N-CA	-5.25	115.24	122.69
1	E	177	GLY	CA-C-O	-5.23	115.78	122.01
1	E	185	ASP	CA-C-O	-5.21	114.75	120.70
1	E	195	VAL	N-CA-CB	5.19	120.81	111.21
1	E	188	GLN	CB-CG-CD	5.19	121.42	112.60
1	E	266	THR	O-C-N	5.18	129.40	123.29
1	E	55	SER	N-CA-CB	5.13	118.63	110.16
1	E	77	ASP	CA-CB-CG	-5.13	107.47	112.60
1	E	180	THR	CA-CB-OG1	-5.12	101.93	109.60
1	E	232	GLN	CA-C-O	5.11	125.54	119.56
1	E	314	GLY	N-CA-C	-5.11	101.91	112.34
1	E	252	ASN	CA-C-O	-5.11	115.11	120.58
1	E	47	PRO	CA-C-O	-5.08	115.62	121.36
1	E	90	VAL	CA-C-O	-5.07	115.15	120.27
1	E	247	PHE	CA-CB-CG	-5.06	108.74	113.80
1	E	139	THR	CA-CB-OG1	-5.03	102.05	109.60
1	E	126	PHE	CA-CB-CG	-5.03	108.77	113.80
1	E	85	VAL	N-CA-C	5.02	115.94	108.46
1	E	18	ILE	CB-CA-C	5.01	118.53	110.82
1	E	317	LEU	CA-C-O	-5.01	115.29	120.70

There are no chirality outliers.

There are no planarity outliers.

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	E	2366	0	2182	19	0
2	I	34	0	45	1	0
3	I	11	0	10	0	0
4	E	311	0	0	3	0
4	I	4	0	0	0	0
All	All	2726	0	2237	20	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 (20) 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:E:106:GLN:C	1:E:107:GLN:HG2	2.17	0.67
1:E:312:SER:HB2	4:E:751:HOH:O	1.97	0.63
1:E:203:GLN:OE1	1:E:228:GLN:HG3	2.00	0.61
1:E:75:TYR:O	4:E:735:HOH:O	2.18	0.57
2:I:2:VAL:C	2:I:1:32L:H16	2.31	0.56
1:E:306:GLN:C	1:E:322:GLN:HG3	2.34	0.53
1:E:233:VAL:HG13	1:E:251:THR:HG21	1.92	0.51
1:E:107:GLN:HE21	1:E:107:GLN:HB3	1.40	0.48
1:E:18:ILE:O	1:E:18:ILE:HD13	2.14	0.47
1:E:40:TRP:HA	1:E:103:GLN:O	2.14	0.47
1:E:195:VAL:HG12	1:E:260:ILE:HG12	1.98	0.46
1:E:242:ALA:HB1	1:E:277:SER:HB2	1.98	0.45
1:E:151:PRO:HB2	1:E:312:SER:OG	2.16	0.44
1:E:152:LEU:HD12	1:E:152:LEU:C	2.43	0.43
1:E:172:SER:HA	1:E:175:TYR:CE1	2.54	0.42
1:E:46:LEU:O	1:E:51:GLN:NE2	2.46	0.42
1:E:117:ASN:ND2	4:E:684:HOH:O	2.53	0.41
1:E:278:GLY:O	1:E:279:ASP:HB3	2.21	0.41
1:E:71:TRP:CE2	1:E:103:GLN:HB3	2.56	0.41
1:E:18:ILE:HD13	1:E:18:ILE:C	2.47	0.40

There are no symmetry-related clashes.

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	E	321/323 (99%)	318 (99%)	2 (1%)	1 (0%)	36	25
2	I	2/4 (50%)	2 (100%)	0	0	100	100
All	All	323/327 (99%)	320 (99%)	2 (1%)	1 (0%)	36	25

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	E	279	ASP

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	E	259/259 (100%)	253 (98%)	6 (2%)	44	33
2	I	2/2 (100%)	2 (100%)	0	100	100
All	All	261/261 (100%)	255 (98%)	6 (2%)	44	33

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	18	ILE
1	E	28	LEU
1	E	52	SER
1	E	72	SER
1	E	107	GLN

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Mol	Chain	Res	Type
1	E	234	SER

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

Mol	Chain	Res	Type
1	E	13	ASN
1	E	31	ASN
1	E	98	HIS
1	E	107	GLN
1	E	194	ASN
1	E	238	GLN
1	E	306	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

1 non-standard protein/DNA/RNA residue is 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	32L	I	1	2	13,13,13	1.91	1 (7%)	13,16,16	3.17	5 (38%)

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	32L	I	1	2	-	5/15/15/15	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	I	1	32L	OH-CH	-6.26	1.30	1.43

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	I	1	32L	CM-CH-CA	-8.11	100.42	112.93
2	I	1	32L	O-C-CM	-4.37	114.49	124.65
2	I	1	32L	CH-CM-C	-3.91	105.47	114.02
2	I	1	32L	OH-CH-CA	3.83	116.76	109.48
2	I	1	32L	OXT-C-CM	-3.51	104.71	111.17

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	I	1	32L	CA-CH-CM-C
2	I	1	32L	OH-CH-CM-C
2	I	1	32L	CM-C-OXT-C9
2	I	1	32L	O-C-OXT-C9
2	I	1	32L	C10-C9-OXT-C

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	I	1	32L	1	0

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

1 ligand is 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	MAN	I	401	1	11,11,12	0.88	0	15,15,17	1.11	1 (6%)

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	MAN	I	401	1	-	0/2/19/22	0/1/1/1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
3	I	401	MAN	O2-C2-C1	-3.00	102.34	109.22

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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.