



Full wwPDB X-ray Structure Validation Report ⓘ

Jun 16, 2024 – 06:47 AM EDT

PDB ID : 5CDF
Title : Structure at 2.3 Å of the alpha/beta monomer of the F-ATPase from *Paracoccus denitrificans*
Authors : Morales-Rios, E.; Montgomery, M.G.; Leslie, A.G.W.; Garcia-Trejo, J.J.; Walker, J.E.
Deposited on : 2015-07-03
Resolution : 2.30 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 : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.37.1
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.37.1

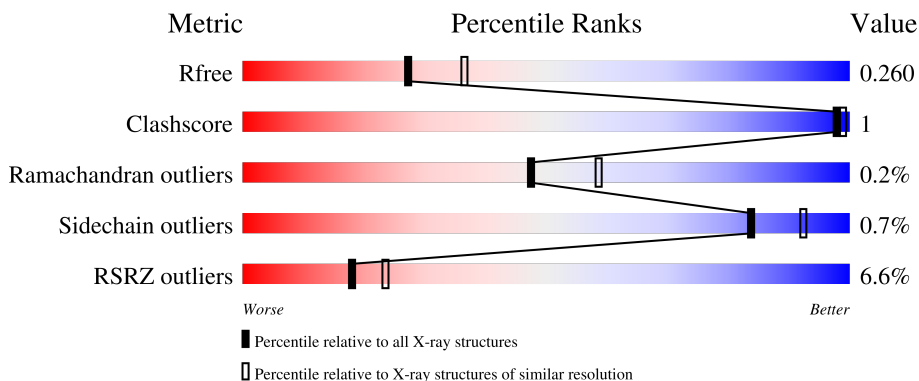
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

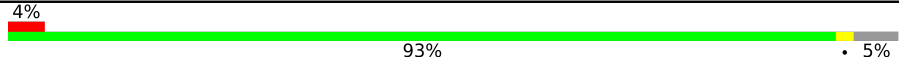
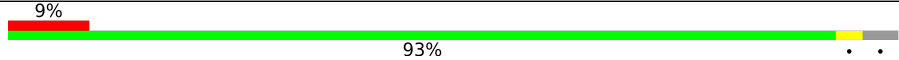
The reported resolution of this entry is 2.30 Å.

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}	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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	511	 4% 93% 5%
2	E	474	 9% 93% 5%

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 7252 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 ATP synthase subunit alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	488	3700	2324	648	712	16	0	1	0

- Molecule 2 is a protein called ATP synthase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	E	456	3420	2155	585	670	10	0	0	0

- Molecule 3 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).



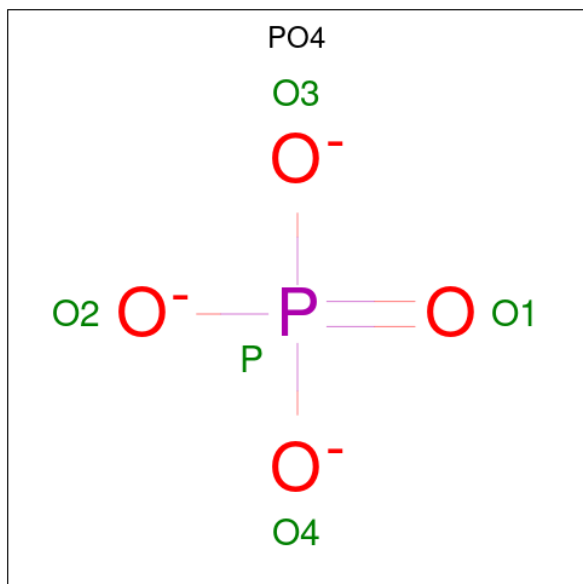
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	6	3	3	0	0
3	A	1	6	3	3	0	0

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			6	3	3		
3	A	1	Total	C	O	0	0
			6	3	3		
3	A	1	Total	C	O	0	0
			6	3	3		
3	E	1	Total	C	O	0	0
			6	3	3		
3	E	1	Total	C	O	0	0
			6	3	3		
3	E	1	Total	C	O	0	0
			6	3	3		

- Molecule 4 is PHOSPHATE ION (three-letter code: PO4) (formula: O₄P).



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

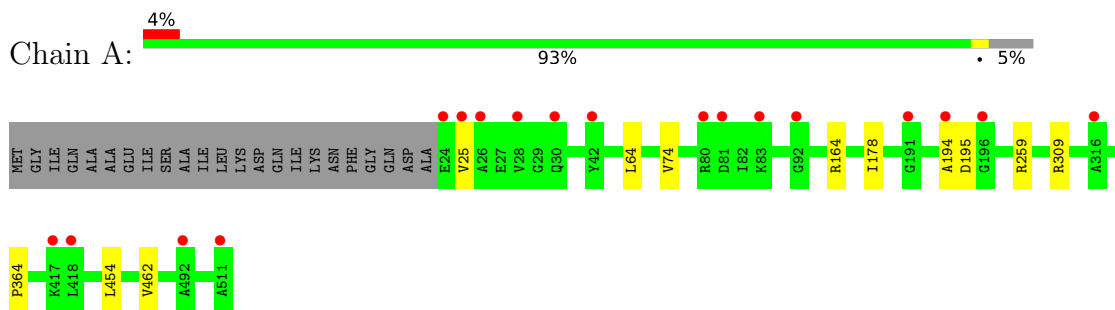
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	45	Total	O	0	0
			45	45		
5	E	34	Total	O	0	0
			34	34		

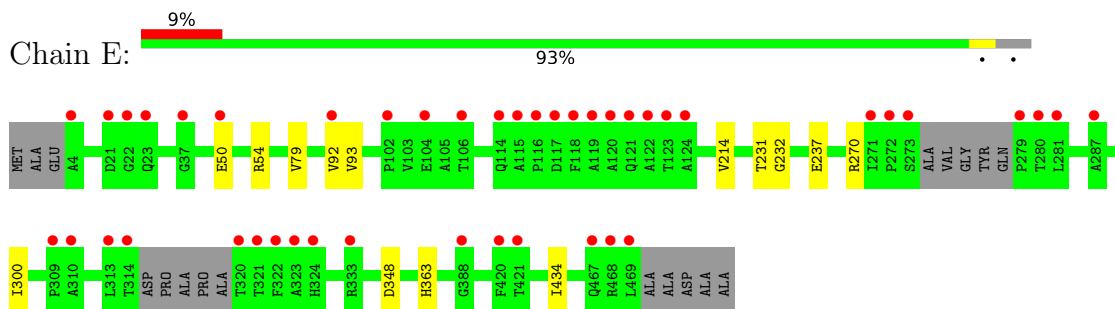
3 Residue-property plots [i](#)

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: ATP synthase subunit alpha



- Molecule 2: ATP synthase subunit beta



4 Data and refinement statistics i

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	72.55Å 102.92Å 89.18Å 90.00° 112.67° 90.00°	Depositor
Resolution (Å)	33.55 – 2.30 33.55 – 2.30	Depositor EDS
% Data completeness (in resolution range)	90.9 (33.55-2.30) 90.9 (33.55-2.30)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.78 (at 2.29Å)	Xtrriage
Refinement program	REFMAC 5.8.0123	Depositor
R, R_{free}	0.225 , 0.257 0.230 , 0.260	Depositor DCC
R_{free} test set	2427 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å ²)	30.2	Xtrriage
Anisotropy	0.068	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.40 , 34.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	0.026 for h,-k,-h-l	Xtrriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	7252	wwPDB-VP
Average B, all atoms (Å ²)	35.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.19% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, PO4

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	0.34	0/3757	0.54	0/5084
2	E	0.35	0/3469	0.56	0/4706
All	All	0.35	0/7226	0.55	0/9790

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

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	3700	0	3762	4	0
2	E	3420	0	3455	6	0
3	A	30	0	40	0	0
3	E	18	0	24	0	0
4	A	5	0	0	0	0
5	A	45	0	0	0	0
5	E	34	0	0	1	0
All	All	7252	0	7281	10	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 1.

All (10) 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:454:LEU:CD2	1:A:462:VAL:HG13	2.41	0.50
2:E:92:VAL:HG13	2:E:93:VAL:HG13	1.96	0.48
2:E:237:GLU:HA	2:E:300:ILE:HD11	1.97	0.47
2:E:79:VAL:HG11	2:E:231:THR:HG23	1.98	0.45
1:A:178:ILE:HD11	1:A:364:PRO:HB3	1.98	0.45
1:A:259:ARG:NH1	1:A:309:ARG:O	2.51	0.44
2:E:54:ARG:NH1	5:E:601:HOH:O	2.51	0.44
2:E:214:VAL:HG21	2:E:232:GLY:HA2	2.02	0.41
2:E:363:HIS:CD2	2:E:434:ILE:HD11	2.56	0.40
1:A:64:LEU:HD12	1:A:74:VAL:HG11	2.04	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 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	487/511 (95%)	477 (98%)	8 (2%)	2 (0%)	34	42
2	E	450/474 (95%)	433 (96%)	17 (4%)	0	100	100
All	All	937/985 (95%)	910 (97%)	25 (3%)	2 (0%)	47	58

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	194	ALA
1	A	25	VAL

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	385/401 (96%)	383 (100%)	2 (0%)	88	95
2	E	366/375 (98%)	363 (99%)	3 (1%)	81	91
All	All	751/776 (97%)	746 (99%)	5 (1%)	84	92

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	164	ARG
1	A	195	ASP
2	E	50	GLU
2	E	270	ARG
2	E	348	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

9 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	PO4	A	606	-	4,4,4	0.96	0	6,6,6	0.46	0
3	GOL	A	602	-	5,5,5	0.25	0	5,5,5	0.23	0
3	GOL	A	605	-	5,5,5	0.24	0	5,5,5	0.23	0
3	GOL	E	502	-	5,5,5	0.32	0	5,5,5	0.21	0
3	GOL	A	603	-	5,5,5	0.24	0	5,5,5	0.16	0
3	GOL	E	501	-	5,5,5	0.33	0	5,5,5	0.17	0
3	GOL	E	503	-	5,5,5	0.33	0	5,5,5	0.04	0
3	GOL	A	601	-	5,5,5	0.28	0	5,5,5	0.07	0
3	GOL	A	604	-	5,5,5	0.31	0	5,5,5	0.22	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
3	GOL	A	602	-	-	0/4/4/4	-
3	GOL	A	605	-	-	2/4/4/4	-
3	GOL	E	502	-	-	0/4/4/4	-
3	GOL	A	603	-	-	2/4/4/4	-
3	GOL	E	501	-	-	4/4/4/4	-
3	GOL	E	503	-	-	4/4/4/4	-
3	GOL	A	601	-	-	2/4/4/4	-
3	GOL	A	604	-	-	0/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (14) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	603	GOL	C1-C2-C3-O3

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Mol	Chain	Res	Type	Atoms
3	A	605	GOL	O1-C1-C2-O2
3	A	605	GOL	O1-C1-C2-C3
3	E	503	GOL	C1-C2-C3-O3
3	E	501	GOL	O1-C1-C2-O2
3	E	501	GOL	O1-C1-C2-C3
3	E	503	GOL	O1-C1-C2-C3
3	E	503	GOL	O2-C2-C3-O3
3	A	601	GOL	O1-C1-C2-C3
3	A	603	GOL	O2-C2-C3-O3
3	E	503	GOL	O1-C1-C2-O2
3	E	501	GOL	C1-C2-C3-O3
3	A	601	GOL	O1-C1-C2-O2
3	E	501	GOL	O2-C2-C3-O3

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

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	488/511 (95%)	0.15	18 (3%) 41 48	19, 31, 53, 73	0
2	E	456/474 (96%)	0.49	44 (9%) 8 10	22, 36, 63, 90	0
All	All	944/985 (95%)	0.32	62 (6%) 18 23	19, 34, 56, 90	0

All (62) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	E	118	PHE	7.2
2	E	123	THR	7.2
2	E	273	SER	7.1
1	A	196	GLY	6.7
2	E	124	ALA	6.2
2	E	119	ALA	5.7
2	E	321	THR	5.4
2	E	117	ASP	5.4
2	E	279	PRO	5.4
1	A	24	GLU	5.4
2	E	271	ILE	5.1
2	E	322	PHE	4.9
1	A	511	ALA	4.9
2	E	272	PRO	4.6
2	E	314	THR	4.6
2	E	4	ALA	4.4
2	E	120	ALA	4.4
2	E	469	LEU	4.3
2	E	280	THR	3.9
2	E	420	PHE	3.8
1	A	25	VAL	3.7
2	E	122	ALA	3.5
2	E	115	ALA	3.5
2	E	467	GLN	3.4

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Mol	Chain	Res	Type	RSRZ
2	E	320	THR	3.4
2	E	114	GLN	3.3
1	A	26	ALA	3.3
2	E	37	GLY	3.2
2	E	281	LEU	3.2
2	E	313	LEU	3.2
2	E	22	GLY	3.1
1	A	316	ALA	3.1
2	E	104	GLU	3.1
1	A	492	ALA	3.0
2	E	116	PRO	3.0
2	E	323	ALA	2.8
1	A	83	LYS	2.8
1	A	42	TYR	2.8
1	A	191	GLY	2.8
1	A	30	GLN	2.7
2	E	287	ALA	2.6
1	A	81	ASP	2.6
2	E	333	ARG	2.5
2	E	121	GLN	2.5
1	A	194	ALA	2.5
2	E	309	PRO	2.5
2	E	468	ARG	2.4
2	E	50	GLU	2.4
1	A	92	GLY	2.4
2	E	21	ASP	2.4
1	A	417	LYS	2.4
1	A	28	VAL	2.3
2	E	310	ALA	2.3
2	E	324	HIS	2.2
2	E	23	GLN	2.2
1	A	418	LEU	2.1
1	A	80	ARG	2.1
2	E	106	THR	2.1
2	E	102	PRO	2.1
2	E	388	GLY	2.0
2	E	421	THR	2.0
2	E	92	VAL	2.0

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 [i](#)

There are no monosaccharides 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
3	GOL	E	503	6/6	0.67	0.37	58,59,60,60	0
3	GOL	E	501	6/6	0.75	0.23	46,47,48,48	0
3	GOL	A	601	6/6	0.75	0.23	49,49,49,50	0
3	GOL	A	604	6/6	0.83	0.19	45,47,47,48	0
3	GOL	A	602	6/6	0.85	0.22	50,51,51,51	0
3	GOL	E	502	6/6	0.87	0.19	46,46,47,47	0
3	GOL	A	605	6/6	0.90	0.16	36,36,36,38	0
3	GOL	A	603	6/6	0.96	0.10	27,28,28,28	0
4	PO4	A	606	5/5	0.97	0.13	35,36,37,37	0

6.5 Other polymers [i](#)

There are no such residues in this entry.