



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 02:05 AM UTC

PDB ID : 6SF2 / pdb_00006sf2
Title : Ternary complex of human bone morphogenetic protein 9 (BMP9) growth factor domain, its prodomain and extracellular domain of activin receptor-like kinase 1 (ALK1).
Authors : Salmon, R.M.; Guo, J.; Yu, M.; Li, W.
Deposited on : 2019-07-31
Resolution : 3.30 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

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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)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

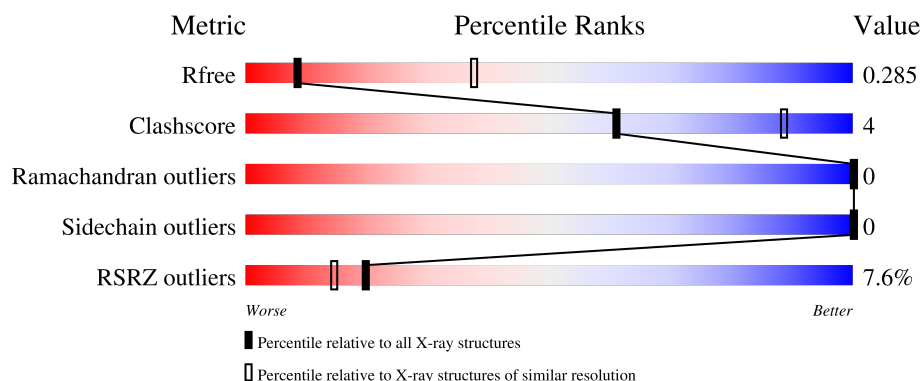
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.30 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.



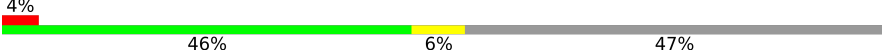
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	1169 (3.32-3.28)
Clashscore	190562	1209 (3.32-3.28)
Ramachandran outliers	187476	1188 (3.32-3.28)
Sidechain outliers	187428	1187 (3.32-3.28)
RSRZ outliers	180081	1169 (3.32-3.28)

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	98	4% 68% 8% 23%
1	D	98	2% 76% • 21%
2	B	110	2% 86% 9% 5%
2	E	110	2% 86% 9% 5%
3	C	297	8% 23% • 75%

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Mol	Chain	Length	Quality of chain
3	F	297	 A horizontal bar chart showing the quality of chain F. The bar is divided into four segments: a small red segment at the beginning labeled '4%', followed by a long green segment labeled '46%', a small yellow segment labeled '6%', and a long grey segment at the end labeled '47%'.

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 4390 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 Serine/threonine-protein kinase receptor R3.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	75	Total	C	N	O	S	0	0	0
			546	334	108	94	10			
1	D	77	Total	C	N	O	S	0	0	0
			587	355	115	107	10			

- Molecule 2 is a protein called Growth/differentiation factor 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	105	Total	C	N	O	S	0	1	0
			786	504	127	146	9			
2	E	105	Total	C	N	O	S	0	1	0
			801	514	129	149	9			

- Molecule 3 is a protein called Growth/differentiation factor 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	73	Total	C	N	O	S	0	0	0
			483	310	86	86	1			
3	F	156	Total	C	N	O	S	0	0	0
			1150	735	188	223	4			

- Molecule 4 is 2-acetamido-2-deoxy-beta-D-glucopyranose (CCD ID: NAG) (formula: C₈H₁₅NO₆).



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

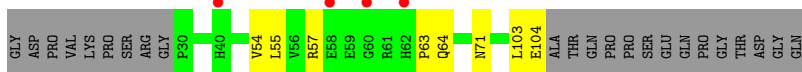
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	3	Total	O	0	0
			3	3		
5	D	2	Total	O	0	0
			2	2		
5	E	1	Total	O	0	0
			1	1		
5	F	3	Total	O	0	0
			3	3		

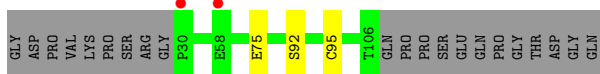
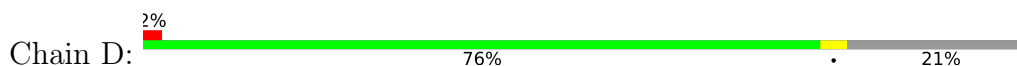
3 Residue-property plots [i](#)

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.

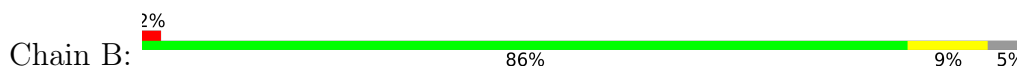
- Molecule 1: Serine/threonine-protein kinase receptor R3



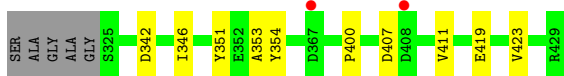
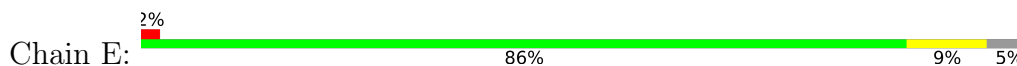
- Molecule 1: Serine/threonine-protein kinase receptor R3



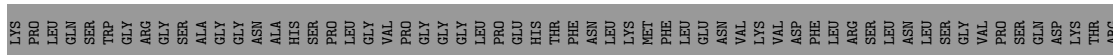
- Molecule 2: Growth/differentiation factor 2



- Molecule 2: Growth/differentiation factor 2



- Molecule 3: Growth/differentiation factor 2



4 Data and refinement statistics

Property	Value	Source
Space group	P 61	Depositor
Cell constants a, b, c, α , β , γ	72.61Å 72.61Å 438.49Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	62.25 – 3.30 62.25 – 3.30	Depositor EDS
% Data completeness (in resolution range)	100.0 (62.25-3.30) 99.9 (62.25-3.30)	Depositor EDS
R_{merge}	0.15	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.72 (at 3.33Å)	Xtriage
Refinement program	PHENIX 1.17_3644	Depositor
R, R_{free}	0.243 , 0.274 0.248 , 0.285	Depositor DCC
R_{free} test set	998 reflections (5.11%)	wwPDB-VP
Wilson B-factor (Å ²)	90.1	Xtriage
Anisotropy	0.284	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 64.2	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.073 for h,-h-k,-l	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	4390	wwPDB-VP
Average B, all atoms (Å ²)	89.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.74% 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 [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	0.10	0/559	0.35	0/762
1	D	0.10	0/602	0.33	0/819
2	B	0.09	0/811	0.24	0/1108
2	E	0.08	0/827	0.25	0/1128
3	C	0.09	0/493	0.26	0/679
3	F	0.09	0/1172	0.26	0/1600
All	All	0.09	0/4464	0.28	0/6096

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	546	0	486	5	0
1	D	587	0	532	2	0
2	B	786	0	724	9	0
2	E	801	0	749	8	0
3	C	483	0	359	6	0
3	F	1150	0	1006	11	0
4	C	14	0	13	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	F	14	0	13	0	0
5	A	3	0	0	0	0
5	D	2	0	0	0	0
5	E	1	0	0	0	0
5	F	3	0	0	0	0
All	All	4390	0	3882	35	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 (35) 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)
3:F:170:VAL:HG23	3:F:197:ILE:HD11	1.74	0.70
1:D:92:SER:HB2	1:D:95:CYS:HB3	1.75	0.67
3:F:177:ASP:O	3:F:188:THR:N	2.33	0.62
3:C:133:LEU:HD23	3:C:134:LEU:H	1.64	0.61
2:B:413:THR:HG22	3:C:110:ARG:HG2	1.86	0.57
2:E:400:PRO:HB3	2:E:419:GLU:HA	1.88	0.55
3:F:170:VAL:HG22	3:F:230:VAL:HG22	1.89	0.54
1:A:57:ARG:HB2	1:A:63:PRO:HB3	1.89	0.54
3:F:148:ALA:HB3	3:F:208:SER:HA	1.90	0.54
3:F:155:SER:HA	3:F:200:GLU:HG2	1.93	0.50
2:B:400:PRO:HB3	2:B:419:GLU:HA	1.92	0.50
3:F:244:VAL:HG22	3:F:245:PRO:HD2	1.94	0.50
3:F:241:ASP:OD1	3:F:242:ILE:N	2.43	0.48
2:E:351:TYR:CZ	2:E:353:ALA:HB2	2.49	0.48
3:C:136:ASN:OD1	4:C:501:NAG:N2	2.47	0.47
3:C:133:LEU:HD23	3:C:134:LEU:N	2.30	0.47
1:A:55:LEU:HD12	1:A:64:GLN:O	2.15	0.46
2:B:351:TYR:CE2	2:B:353:ALA:HB2	2.52	0.45
3:F:152:LEU:HD23	3:F:252:PRO:HB3	1.99	0.45
2:B:351:TYR:CZ	2:B:353:ALA:HB2	2.51	0.45
1:A:71:ASN:HB2	2:B:366:ASP:OD2	2.17	0.45
2:E:346:ILE:HD13	3:F:85:PRO:HG3	1.97	0.45
2:E:407:ASP:OD1	2:E:411:VAL:N	2.50	0.45
2:B:344:TRP:CZ2	1:D:75:GLU:HB3	2.52	0.44
2:B:342:ASP:N	2:B:342:ASP:OD1	2.51	0.44
1:A:54:VAL:HG11	2:B:363:PRO:HG3	1.98	0.43
2:E:351:TYR:CE2	2:E:353:ALA:HB2	2.53	0.43
3:F:136:ASN:HA	3:F:224:ASN:ND2	2.32	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:C:148:ALA:HB3	3:C:208:SER:HA	2.01	0.43
3:F:164:HIS:O	3:F:164:HIS:ND1	2.52	0.42
2:E:342:ASP:OD1	2:E:342:ASP:N	2.52	0.41
2:E:354:TYR:HB2	2:E:423:VAL:HB	2.02	0.41
1:A:103:LEU:O	1:A:104:GLU:HB2	2.21	0.41
2:B:373:HIS:NE2	2:E:354:TYR:O	2.51	0.41
3:C:133:LEU:HD23	3:C:134:LEU:O	2.21	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	73/98 (74%)	71 (97%)	2 (3%)	0	100	100
1	D	75/98 (76%)	73 (97%)	2 (3%)	0	100	100
2	B	104/110 (94%)	101 (97%)	3 (3%)	0	100	100
2	E	104/110 (94%)	101 (97%)	3 (3%)	0	100	100
3	C	65/297 (22%)	60 (92%)	5 (8%)	0	100	100
3	F	142/297 (48%)	133 (94%)	9 (6%)	0	100	100
All	All	563/1010 (56%)	539 (96%)	24 (4%)	0	100	100

There are no Ramachandran outliers to report.

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	56/86 (65%)	56 (100%)	0	100	100
1	D	66/86 (77%)	66 (100%)	0	100	100
2	B	82/93 (88%)	82 (100%)	0	100	100
2	E	86/93 (92%)	86 (100%)	0	100	100
3	C	32/265 (12%)	32 (100%)	0	100	100
3	F	116/265 (44%)	116 (100%)	0	100	100
All	All	438/888 (49%)	438 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	335	ASN
1	D	98	ASN
2	E	335	ASN
3	F	198	GLN

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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

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	C	501	3	14,14,15	0.39	0	17,19,21	0.58	0
4	NAG	F	501	3	14,14,15	0.37	0	17,19,21	0.47	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	C	501	3	-	2/6/23/26	0/1/1/1
4	NAG	F	501	3	-	0/6/23/26	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	C	501	NAG	O5-C5-C6-O6
4	C	501	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	C	501	NAG	1	0

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	75/98 (76%)	0.40	4 (5%)	32	22	73, 84, 109, 118	0
1	D	77/98 (78%)	0.19	2 (2%)	57	38	68, 80, 89, 102	1 (1%)
2	B	105/110 (95%)	0.20	2 (1%)	66	48	49, 81, 96, 103	1 (0%)
2	E	105/110 (95%)	-0.02	2 (1%)	66	48	47, 75, 85, 89	1 (0%)
3	C	73/297 (24%)	1.59	24 (32%)	1	1	110, 126, 137, 139	0
3	F	156/297 (52%)	0.61	11 (7%)	22	15	80, 93, 118, 127	0
All	All	591/1010 (58%)	0.47	45 (7%)	20	14	47, 85, 127, 139	3 (0%)

All (45) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	C	260	ASP	5.3
3	F	119	SER	4.5
3	C	102	THR	4.3
3	F	246	PRO	3.9
3	C	133	LEU	3.9
3	F	236	GLY	3.7
3	C	207	VAL	3.7
1	A	60	GLY	3.6
3	F	126	PHE	3.4
3	C	104	PRO	3.4
3	F	166	LEU	3.3
3	C	209	SER	3.2
1	A	58	GLU	3.2
3	F	102	THR	3.1
2	E	408	ASP	3.1
3	C	113	SER	3.0
3	C	105	ALA	3.0
3	F	159	HIS	3.0
3	F	107	ASN	3.0

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Mol	Chain	Res	Type	RSRZ
3	C	146	THR	2.9
3	C	101	SER	2.9
3	C	96	TYR	2.8
1	A	62	HIS	2.8
3	C	138	SER	2.8
3	C	134	LEU	2.8
2	B	325	SER	2.7
1	D	30	PRO	2.6
2	B	416	TYR	2.5
3	C	202	TRP	2.5
3	C	132	ILE	2.4
3	C	208	SER	2.4
3	C	94	ASN	2.4
3	C	107	ASN	2.4
3	C	135	PHE	2.4
3	C	214	TRP	2.3
3	C	254	PHE	2.3
1	A	40	HIS	2.3
3	C	99	ASP	2.2
2	E	367	ASP	2.1
3	F	261	HIS	2.1
3	C	106	SER	2.1
3	F	217	SER	2.1
1	D	58	GLU	2.1
3	C	259	ASN	2.0
3	F	178	GLY	2.0

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](#)

There are no oligosaccharides 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($\text{\AA}^2$)	Q<0.9
4	NAG	F	501	14/15	0.36	0.19	121,122,123,123	0
4	NAG	C	501	14/15	0.47	0.17	130,133,134,135	0

6.5 Other polymers [i](#)

There are no such residues in this entry.