



# wwPDB EM Validation Summary Report ⓘ

Oct 28, 2024 – 02:41 PM JST

PDB ID : 8JFK  
EMDB ID : EMD-36212  
Title : PhK holoenzyme in inactive state, muscle isoform  
Authors : Yang, X.K.; Xiao, J.Y.  
Deposited on : 2023-05-18  
Resolution : 2.90 Å(reported)

This is a wwPDB EM Validation Summary Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto: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 ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

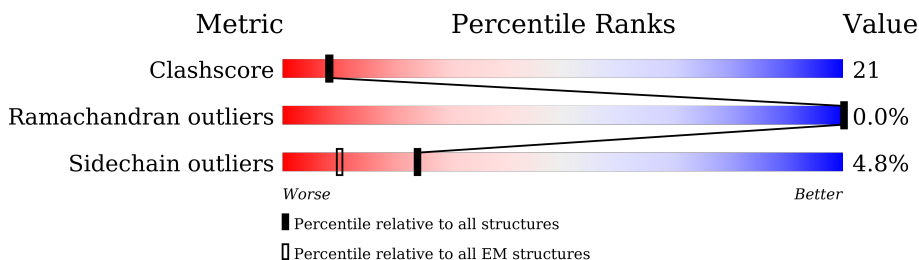
EMDB validation analysis : **FAILED**  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
MolProbity : 4.02b-467  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
MapQ : **FAILED**  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.39

# 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 2.90 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  $\geq 3$ , 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  $\leq 5\%$ .

Mol	Chain	Length	Quality of chain
1	B	1093	51% 40% 5%
1	F	1093	53% 39% 5%
1	J	1093	57% 35% 5%
1	N	1093	62% 30% 5%
2	A	1223	49% 30% 19%
2	E	1223	47% 32% 19%
2	I	1223	52% 26% 19%
2	M	1223	53% 26% 19%
3	D	149	64% 30%

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Mol	Chain	Length	Quality of chain	
3	H	149	64%	30%
3	L	149	64%	30%
3	P	149	62%	32%
4	C	387	50%	43%
4	G	387	49%	44%
4	K	387	49%	44%
4	O	387	50%	42%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	FAR	A	1301	-	X	X	-
5	FAR	B	1101	-	-	X	-
5	FAR	E	1301	-	X	X	-
5	FAR	F	1101	-	-	X	-
5	FAR	I	1301	-	X	X	-
5	FAR	J	1101	-	X	X	-
5	FAR	M	1301	-	X	-	-
5	FAR	N	1101	-	-	X	-

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 81428 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 Phosphorylase b kinase regulatory subunit beta.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	B	1033	Total 8342	C 5338	N 1424	O 1543	S 37	0	0
1	N	1033	Total 8342	C 5338	N 1424	O 1543	S 37	0	0
1	J	1033	Total 8342	C 5338	N 1424	O 1543	S 37	0	0
1	F	1033	Total 8342	C 5338	N 1424	O 1543	S 37	0	0

- Molecule 2 is a protein called Phosphorylase b kinase regulatory subunit alpha, skeletal muscle isoform.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	M	986	Total 7801	C 4976	N 1319	O 1460	S 46	0	0
2	A	986	Total 7801	C 4976	N 1319	O 1460	S 46	0	0
2	I	986	Total 7801	C 4976	N 1319	O 1460	S 46	0	0
2	E	986	Total 7801	C 4976	N 1319	O 1460	S 46	0	0

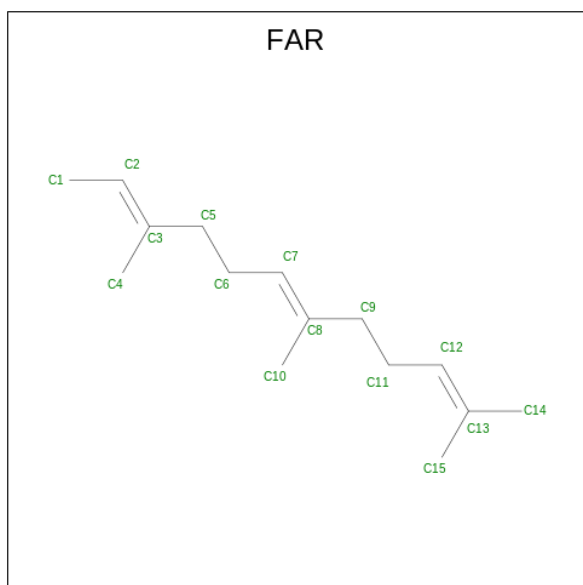
- Molecule 3 is a protein called Calmodulin-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	D	145	Total 1143	C 701	N 184	O 249	S 9	0	0
3	H	145	Total 1143	C 701	N 184	O 249	S 9	0	0
3	L	145	Total 1143	C 701	N 184	O 249	S 9	0	0
3	P	145	Total 1143	C 701	N 184	O 249	S 9	0	0

- Molecule 4 is a protein called Phosphorylase b kinase gamma catalytic chain, skeletal muscle/heart isoform.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	C	371	Total 3041	C 1951	N 525	O 550	S 15	0	0
4	G	371	Total 3041	C 1951	N 525	O 550	S 15	0	0
4	K	371	Total 3041	C 1951	N 525	O 550	S 15	0	0
4	O	371	Total 3041	C 1951	N 525	O 550	S 15	0	0

- Molecule 5 is FARNESYL (three-letter code: FAR) (formula: C<sub>15</sub>H<sub>26</sub>) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms		AltConf
5	B	1	Total 15	C 15	0
5	M	1	Total 15	C 15	0
5	A	1	Total 15	C 15	0
5	N	1	Total 15	C 15	0
5	J	1	Total 15	C 15	0
5	I	1	Total 15	C 15	0

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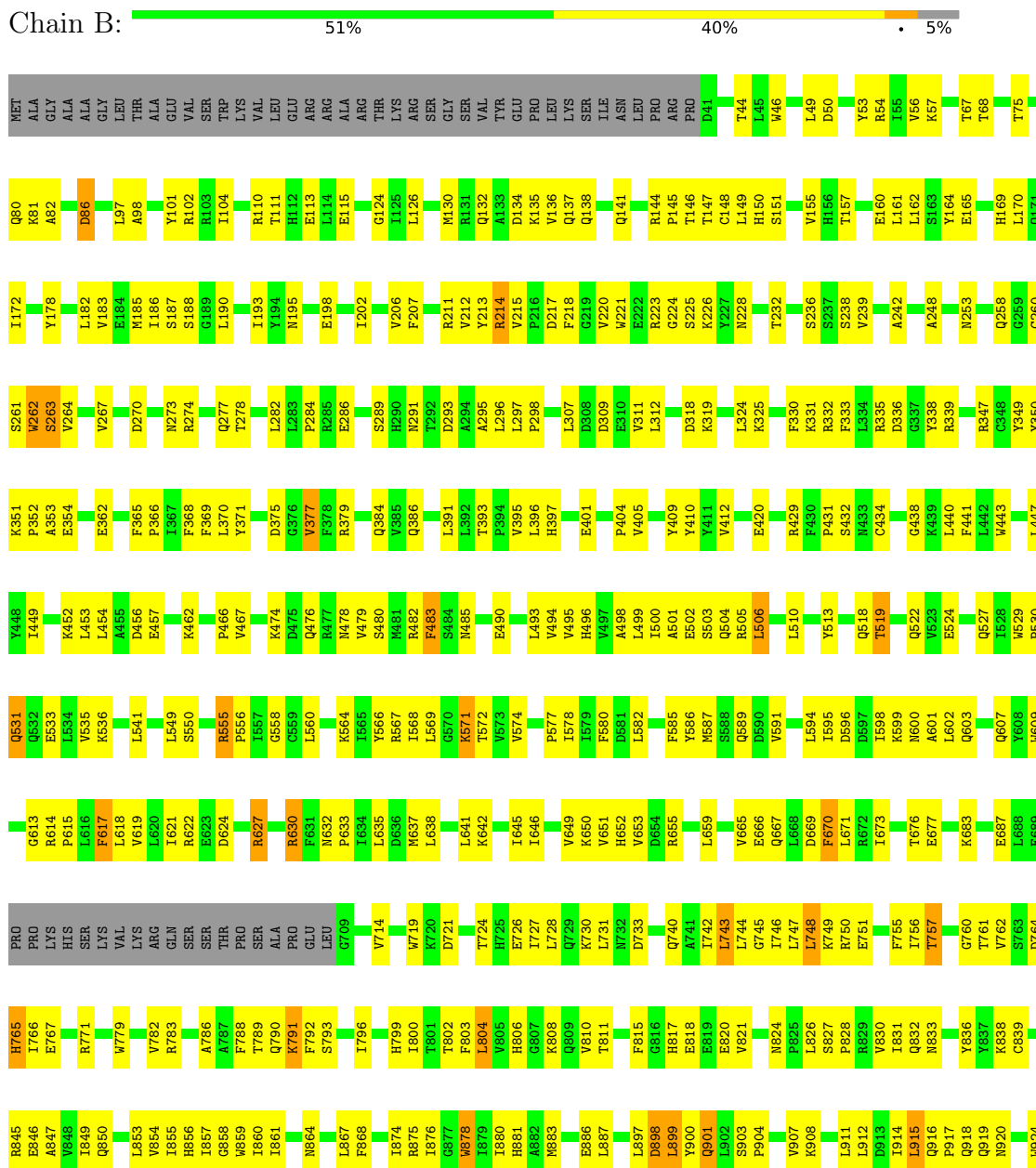
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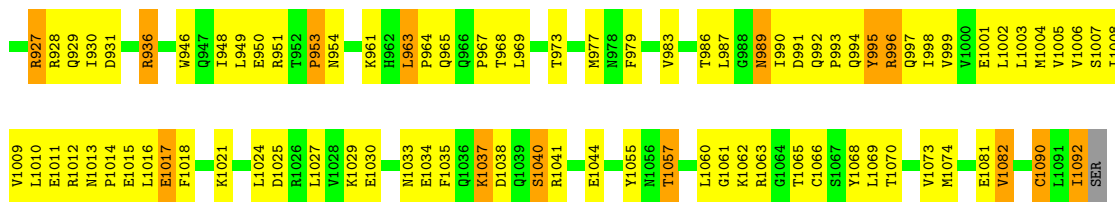
Mol	Chain	Residues	Atoms	AltConf
5	F	1	Total C 15 15	0
5	E	1	Total C 15 15	0

### 3 Residue-property plots

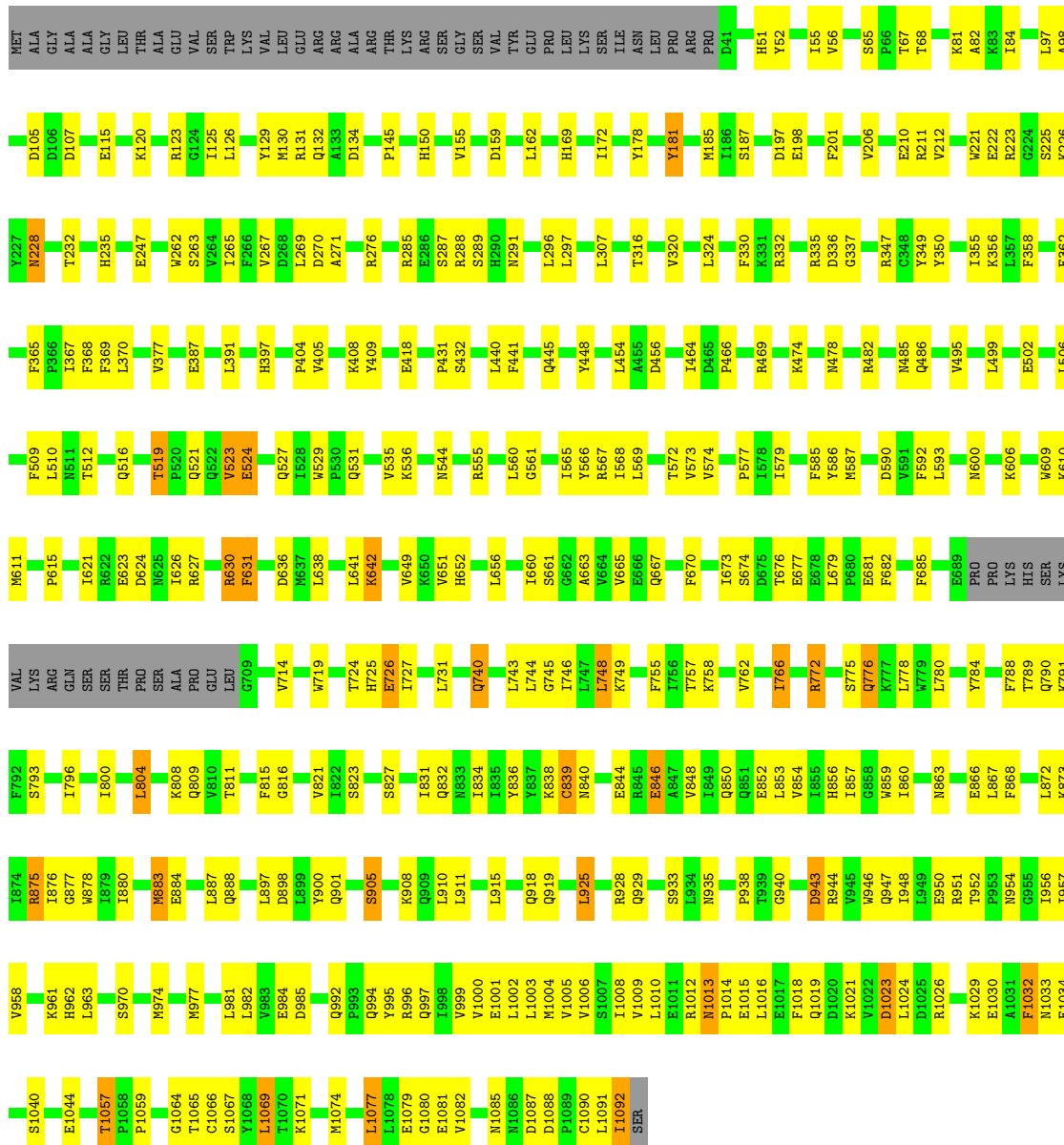
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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: Phosphorylase b kinase regulatory subunit beta





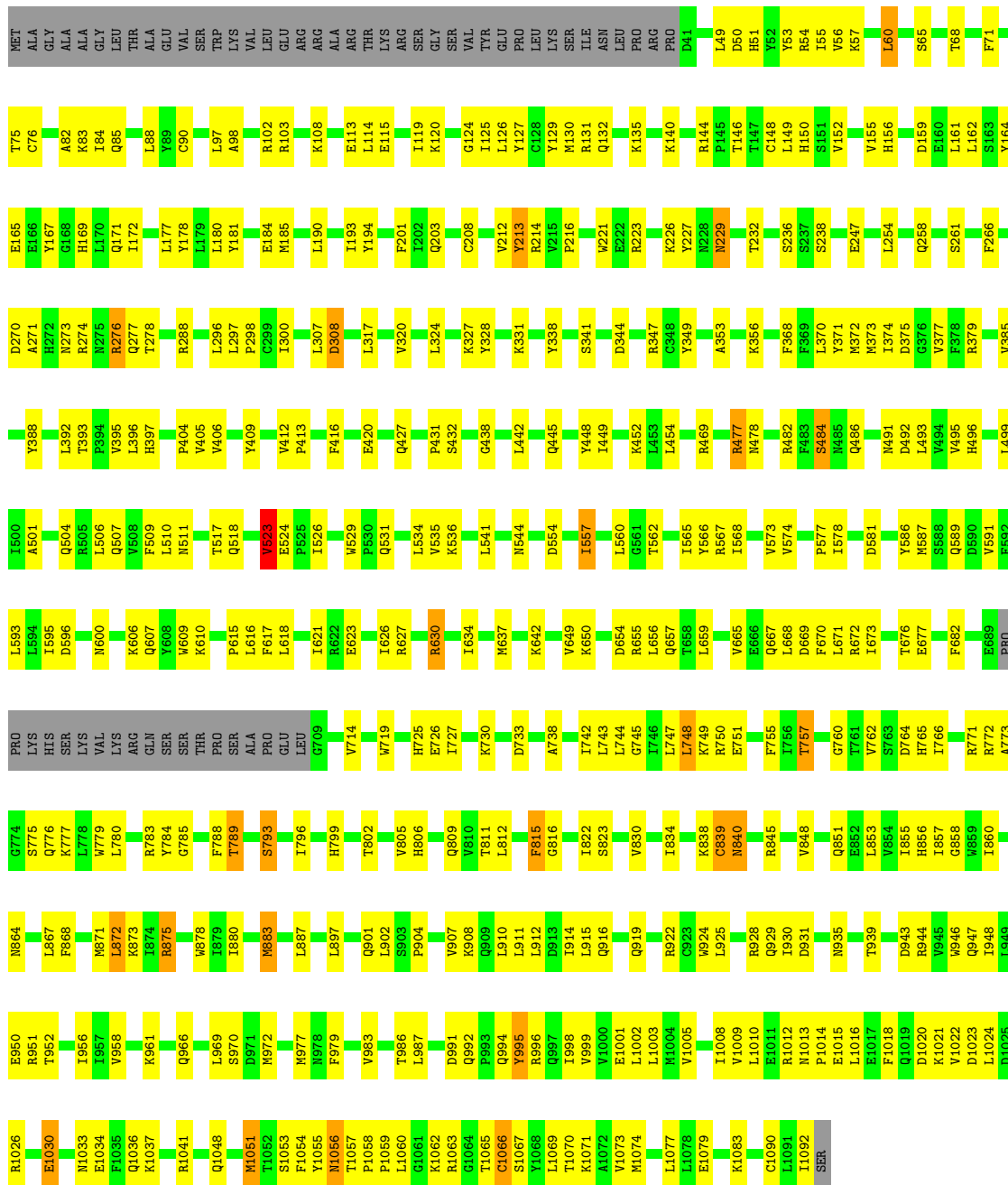
• Molecule 1: Phosphorylase b kinase regulatory subunit beta



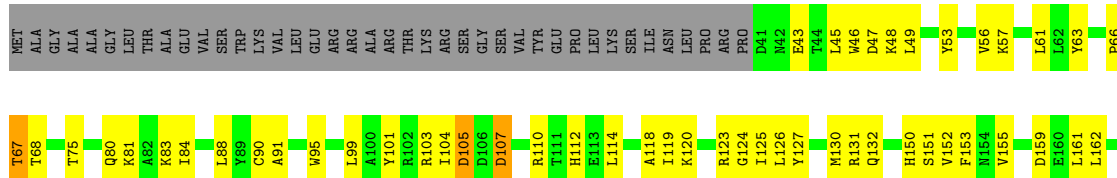
• Molecule 1: Phosphorylase b kinase regulatory subunit beta

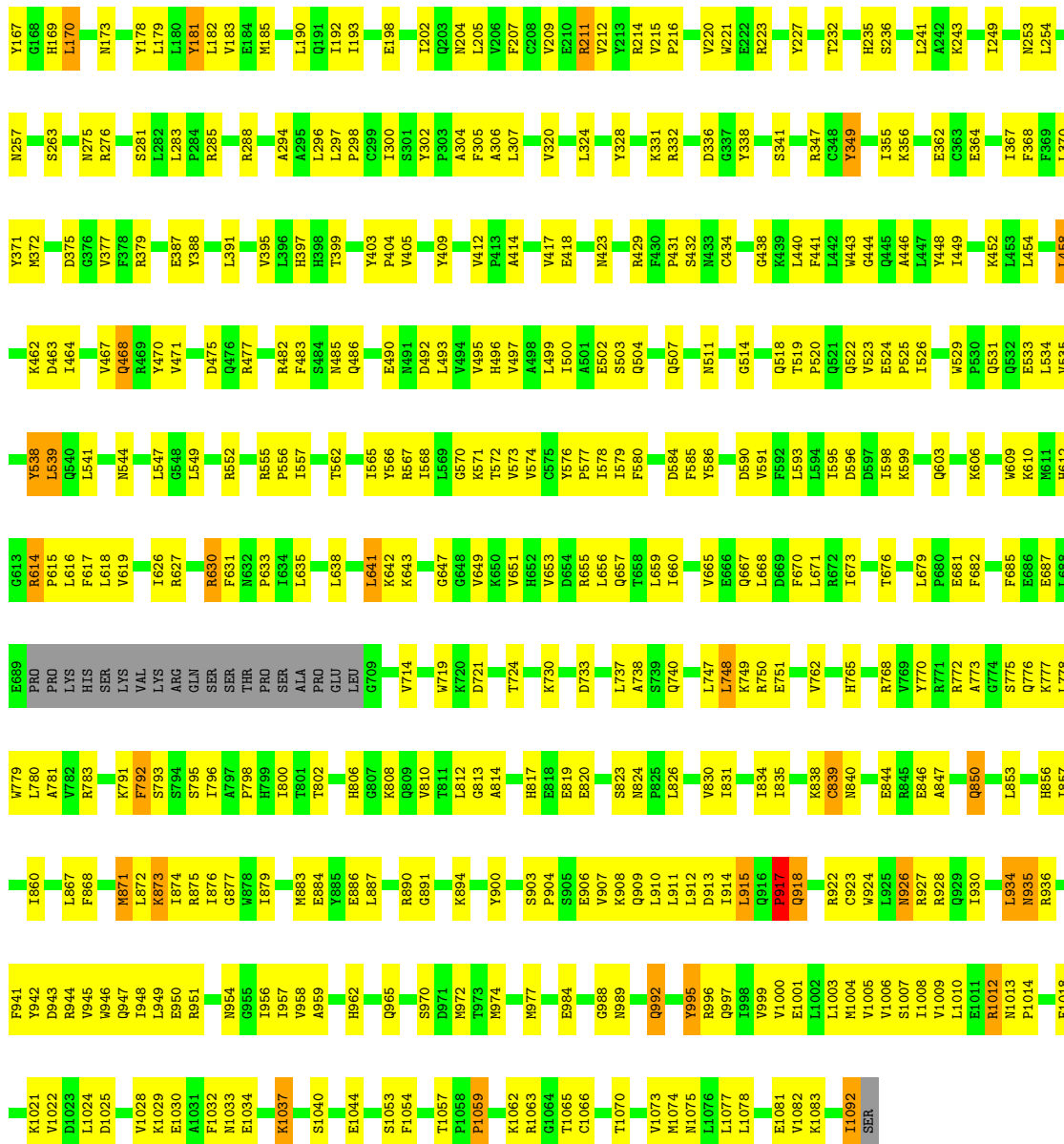




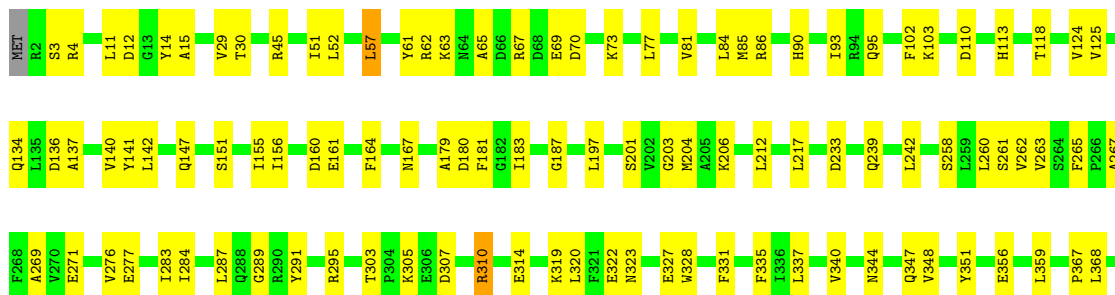


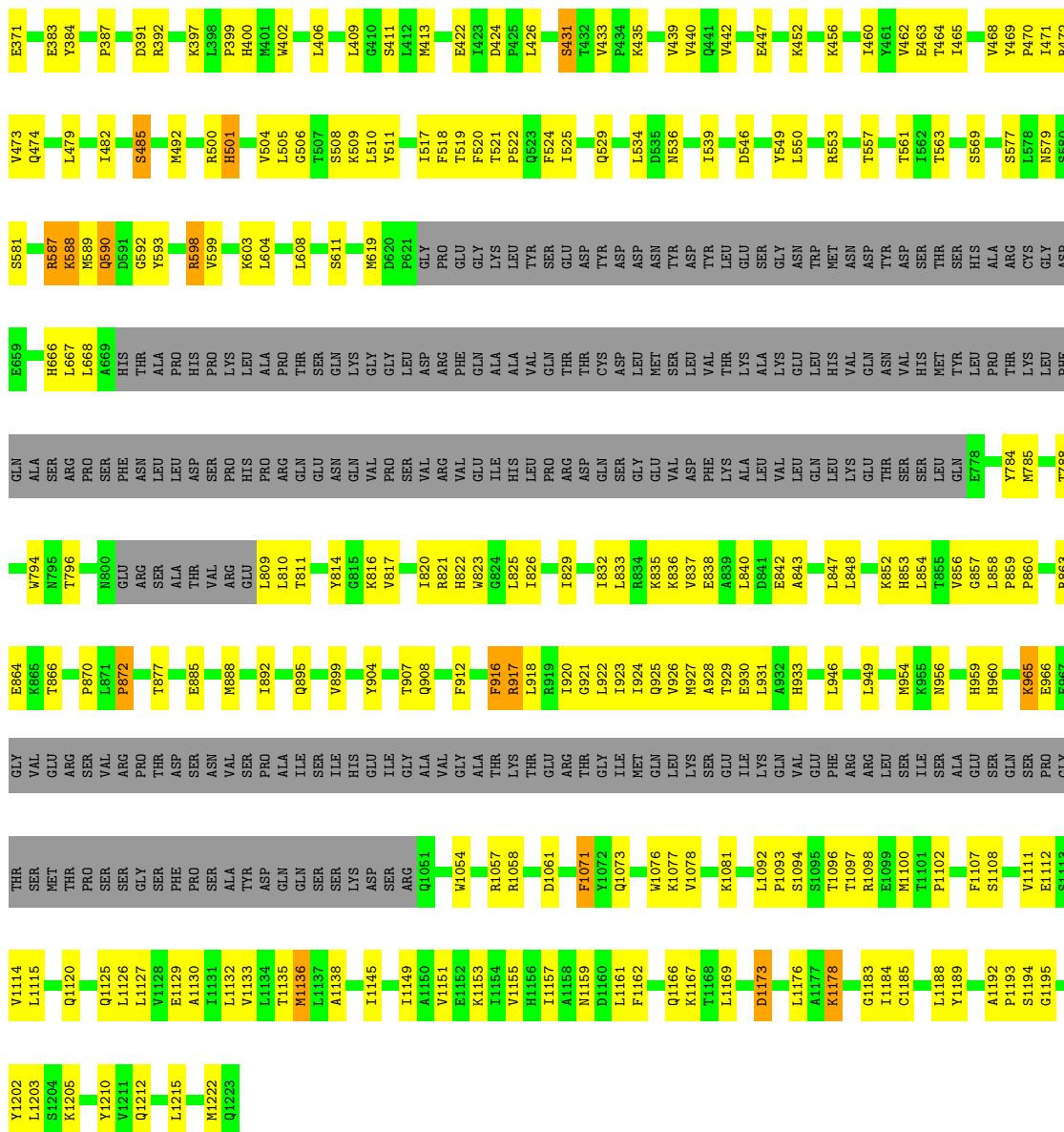
• Molecule 1: Phosphorylase b kinase regulatory subunit beta



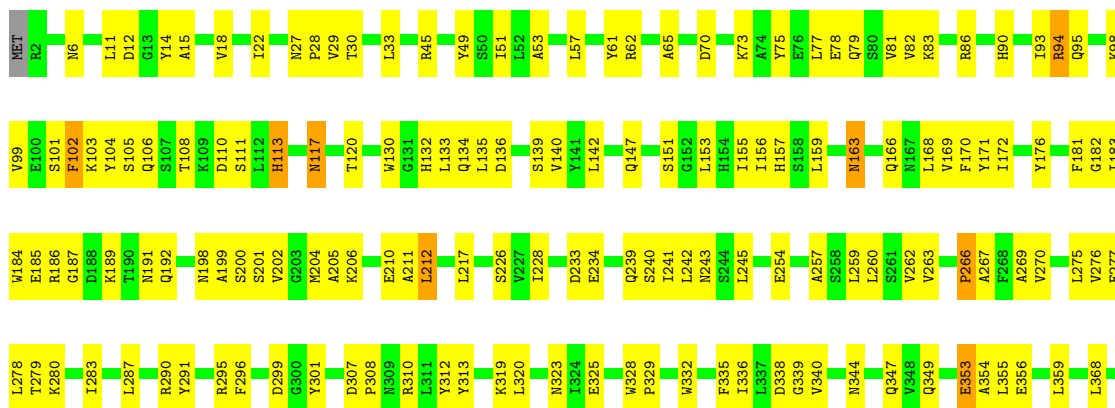


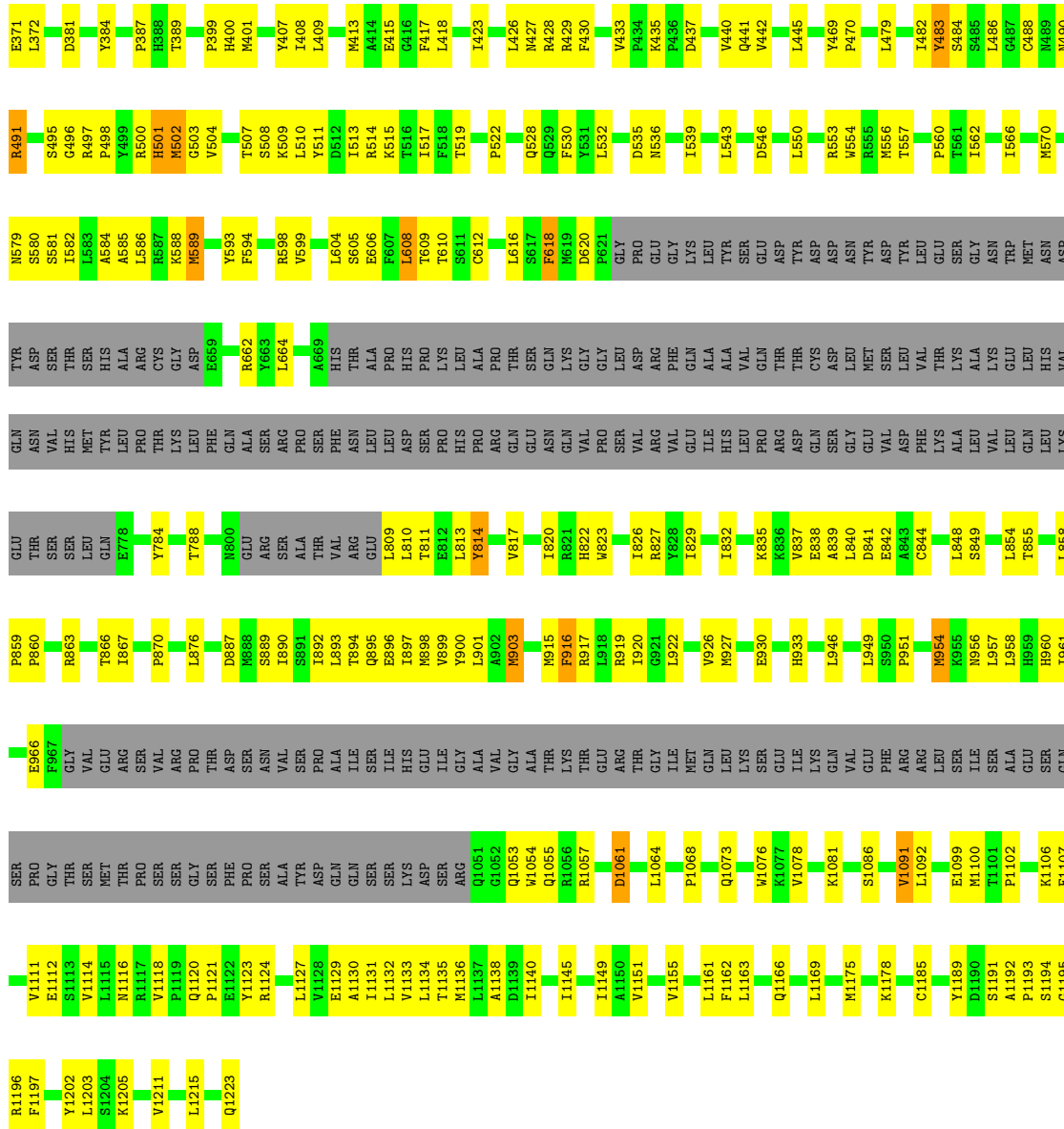
● Molecule 2: Phosphorylase b kinase regulatory subunit alpha, skeletal muscle isoform



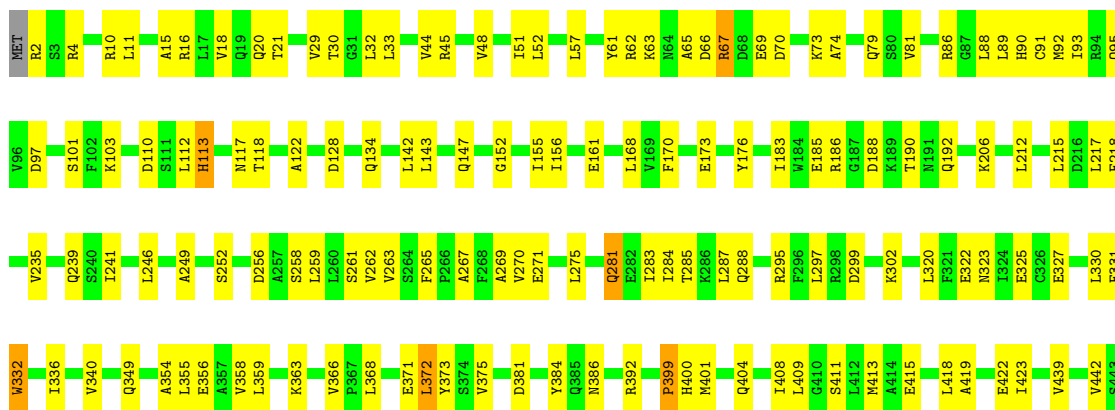


● Molecule 2: Phosphorylase b kinase regulatory subunit alpha, skeletal muscle isoform

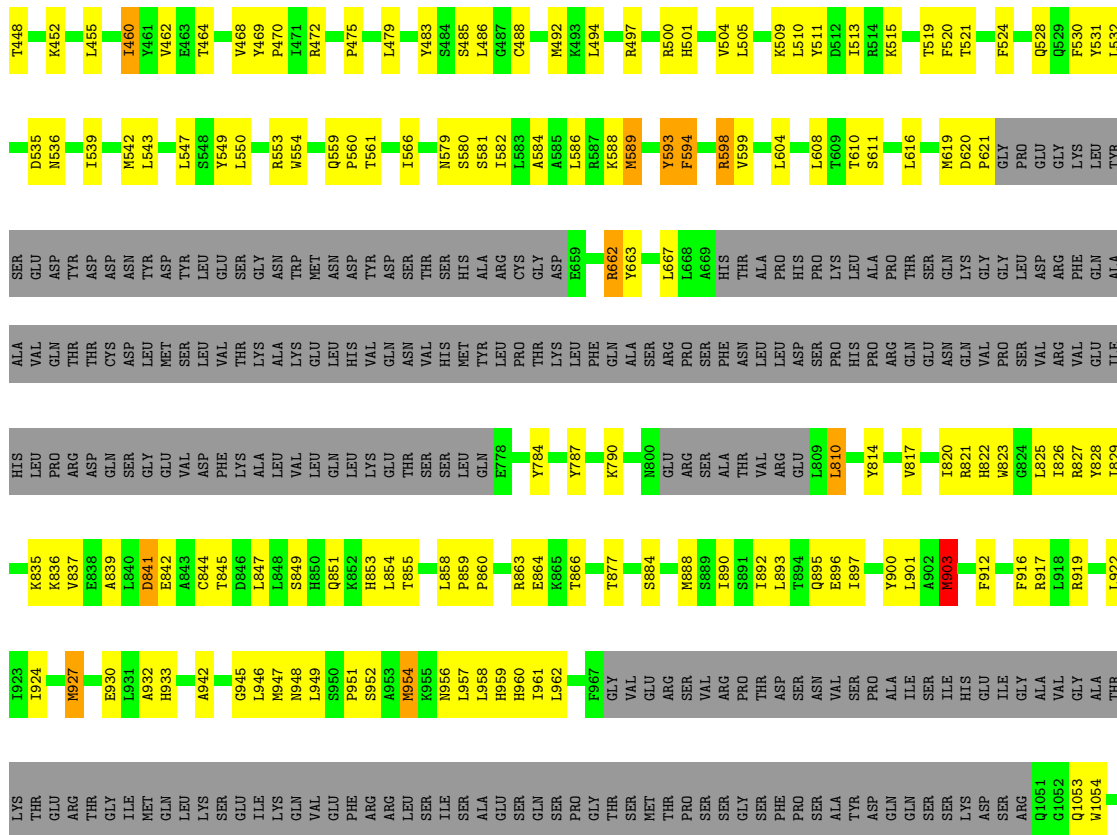




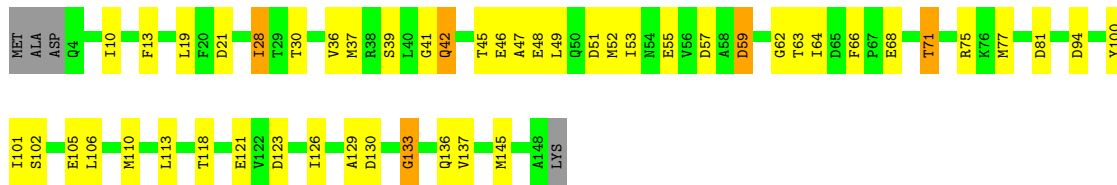
● Molecule 2: Phosphorylase b kinase regulatory subunit alpha, skeletal muscle isoform



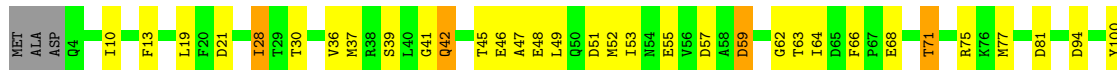




● Molecule 3: Calmodulin-1



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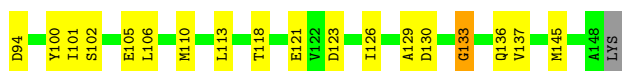
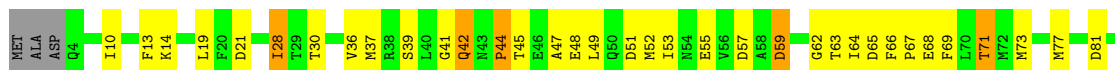




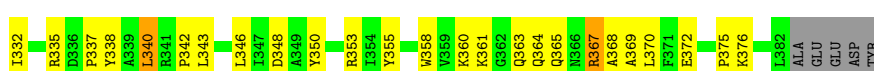
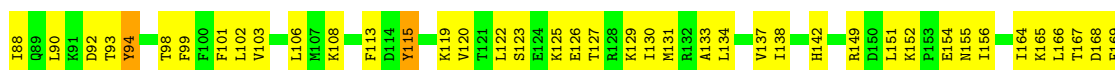
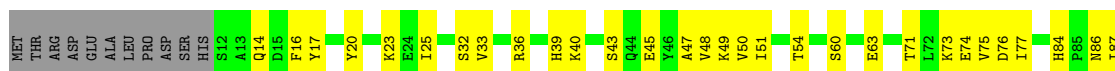
• Molecule 3: Calmodulin-1



• Molecule 3: Calmodulin-1

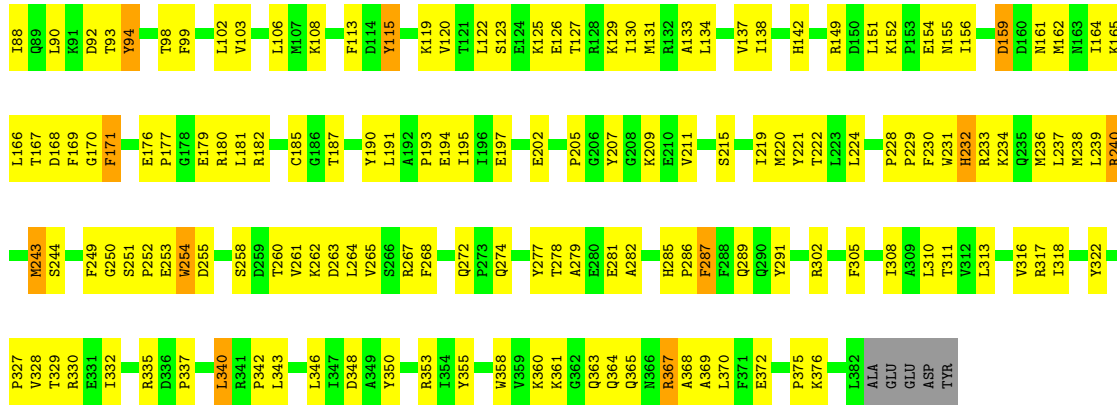


• Molecule 4: Phosphorylase b kinase gamma catalytic chain, skeletal muscle/heart isoform

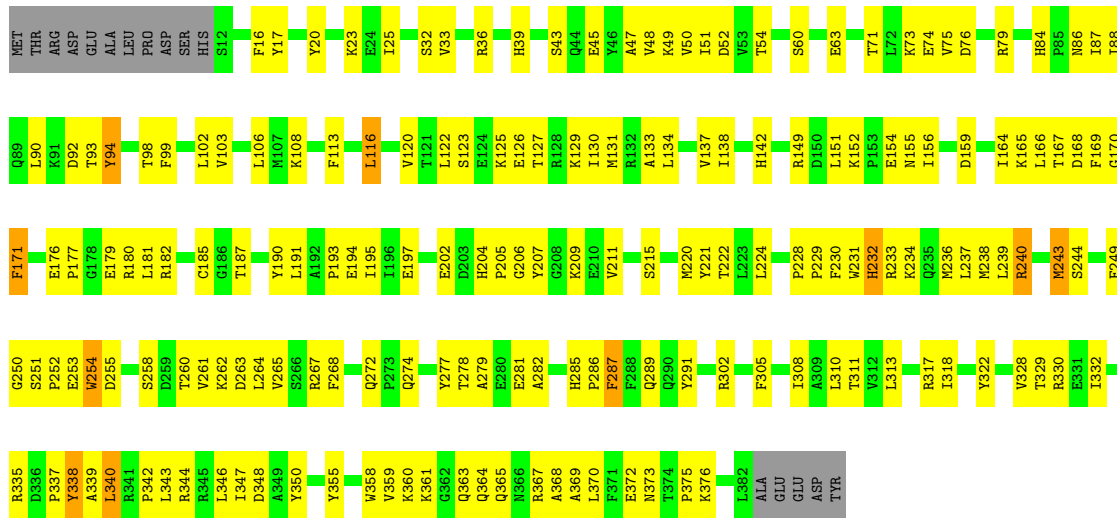


• Molecule 4: Phosphorylase b kinase gamma catalytic chain, skeletal muscle/heart isoform

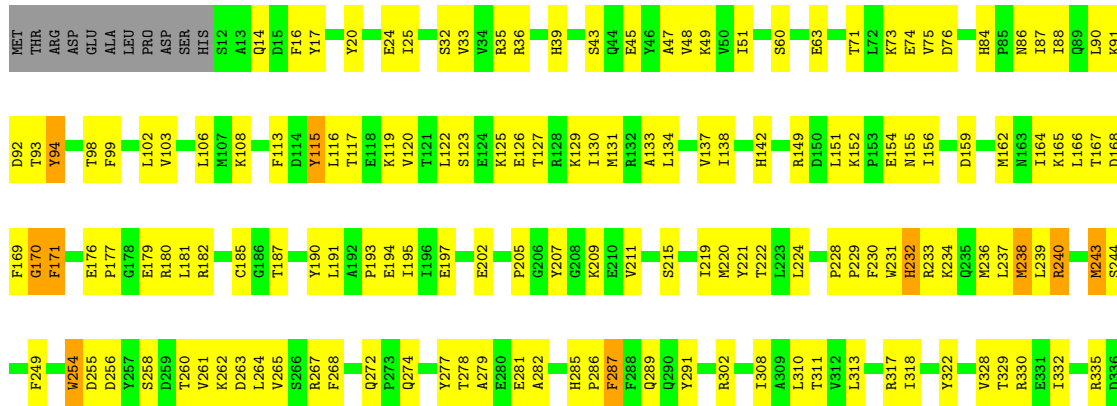




● Molecule 4: Phosphorylase b kinase gamma catalytic chain, skeletal muscle/heart isoform



● Molecule 4: Phosphorylase b kinase gamma catalytic chain, skeletal muscle/heart isoform





P337	Y338	A339	L340	R341	P342	L343	R344	R345	L346	I347	D348	A349	Y350	A351	F352	R353	I354	Y355	W358	V359	K360	K361	G362	Q363	Q364	Q365	N366	R367	A368	L369	L370	F371	E372	P375	L382	ALA	GLU	GLU	ASP	TYR
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-----	-----	-----	-----	-----

## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	623973	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	1.5	Depositor
Minimum defocus (nm)	1100	Depositor
Maximum defocus (nm)	1500	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: FAR

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	B	0.41	0/8529	0.66	9/11558 (0.1%)
1	F	0.32	0/8529	0.58	6/11558 (0.1%)
1	J	0.34	0/8529	0.57	3/11558 (0.0%)
1	N	0.31	0/8529	0.53	2/11558 (0.0%)
2	A	0.28	0/7962	0.56	4/10785 (0.0%)
2	E	0.28	0/7962	0.54	2/10785 (0.0%)
2	I	0.29	0/7962	0.55	5/10785 (0.0%)
2	M	0.28	0/7962	0.53	1/10785 (0.0%)
3	D	0.81	0/1155	0.94	4/1551 (0.3%)
3	H	0.80	0/1155	0.93	4/1551 (0.3%)
3	L	0.80	0/1155	0.96	4/1551 (0.3%)
3	P	0.80	0/1155	0.96	5/1551 (0.3%)
4	C	0.33	0/3112	0.62	2/4209 (0.0%)
4	G	0.33	0/3112	0.63	2/4209 (0.0%)
4	K	0.37	0/3112	0.65	2/4209 (0.0%)
4	O	0.35	0/3112	0.63	2/4209 (0.0%)
All	All	0.37	0/83032	0.60	57/112412 (0.1%)

There are no bond length outliers.

The worst 5 of 57 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	I	399	PRO	CA-N-CD	-9.84	97.73	111.50
1	J	523	VAL	N-CA-C	-9.29	85.92	111.00
2	E	367	PRO	CA-N-CD	-9.11	98.75	111.50
2	M	872	PRO	CA-N-CD	-9.00	98.91	111.50
3	D	59	ASP	N-CA-C	-8.96	86.79	111.00

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	B	8342	0	8327	420	0
1	F	8342	0	8327	380	0
1	J	8342	0	8328	353	0
1	N	8342	0	8328	284	0
2	A	7801	0	7821	327	0
2	E	7801	0	7821	320	0
2	I	7801	0	7821	298	0
2	M	7801	0	7821	253	0
3	D	1143	0	1071	80	0
3	H	1143	0	1071	83	0
3	L	1143	0	1071	86	0
3	P	1143	0	1071	82	0
4	C	3041	0	3054	202	0
4	G	3041	0	3054	229	0
4	K	3041	0	3054	222	0
4	O	3041	0	3054	208	0
5	A	15	0	20	10	0
5	B	15	0	24	22	0
5	E	15	0	20	11	0
5	F	15	0	24	28	0
5	I	15	0	21	9	0
5	J	15	0	25	43	0
5	M	15	0	21	5	0
5	N	15	0	23	16	0
All	All	81428	0	81272	3488	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 21.

The worst 5 of 3488 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:J:1060:LEU:HD21	5:F:1101:FAR:C4	1.33	1.51
1:J:1074:MET:CE	5:J:1101:FAR:H12	1.43	1.47
1:J:1074:MET:CE	5:J:1101:FAR:C12	1.96	1.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:O:24:GLU:CD	4:O:36:ARG:HH21	1.20	1.41
4:G:26:LEU:HD21	4:G:36:ARG:CD	1.51	1.37

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	B	1029/1093 (94%)	997 (97%)	32 (3%)	0	100	100
1	F	1029/1093 (94%)	991 (96%)	37 (4%)	1 (0%)	48	77
1	J	1029/1093 (94%)	998 (97%)	30 (3%)	1 (0%)	48	77
1	N	1029/1093 (94%)	1002 (97%)	27 (3%)	0	100	100
2	A	976/1223 (80%)	955 (98%)	21 (2%)	0	100	100
2	E	976/1223 (80%)	957 (98%)	19 (2%)	0	100	100
2	I	976/1223 (80%)	956 (98%)	19 (2%)	1 (0%)	48	77
2	M	976/1223 (80%)	960 (98%)	16 (2%)	0	100	100
3	D	143/149 (96%)	140 (98%)	3 (2%)	0	100	100
3	H	143/149 (96%)	140 (98%)	3 (2%)	0	100	100
3	L	143/149 (96%)	141 (99%)	2 (1%)	0	100	100
3	P	143/149 (96%)	140 (98%)	3 (2%)	0	100	100
4	C	369/387 (95%)	360 (98%)	9 (2%)	0	100	100
4	G	369/387 (95%)	361 (98%)	8 (2%)	0	100	100
4	K	369/387 (95%)	359 (97%)	10 (3%)	0	100	100
4	O	369/387 (95%)	361 (98%)	8 (2%)	0	100	100
All	All	10068/11408 (88%)	9818 (98%)	247 (2%)	3 (0%)	100	100

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	J	872	LEU
2	I	795	ASN
1	F	917	PRO

### 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	B	924/975 (95%)	853 (92%)	71 (8%)	10	31
1	F	924/975 (95%)	868 (94%)	56 (6%)	15	43
1	J	924/975 (95%)	880 (95%)	44 (5%)	21	54
1	N	924/975 (95%)	866 (94%)	58 (6%)	15	42
2	A	857/1068 (80%)	821 (96%)	36 (4%)	25	59
2	E	857/1068 (80%)	823 (96%)	34 (4%)	27	61
2	I	857/1068 (80%)	822 (96%)	35 (4%)	26	60
2	M	857/1068 (80%)	827 (96%)	30 (4%)	31	66
3	D	124/127 (98%)	122 (98%)	2 (2%)	58	84
3	H	124/127 (98%)	122 (98%)	2 (2%)	58	84
3	L	124/127 (98%)	121 (98%)	3 (2%)	44	76
3	P	124/127 (98%)	121 (98%)	3 (2%)	44	76
4	C	335/349 (96%)	320 (96%)	15 (4%)	23	56
4	G	335/349 (96%)	321 (96%)	14 (4%)	25	59
4	K	335/349 (96%)	321 (96%)	14 (4%)	25	59
4	O	335/349 (96%)	320 (96%)	15 (4%)	23	56
All	All	8960/10076 (89%)	8528 (95%)	432 (5%)	24	54

5 of 432 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	J	1030	GLU

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Mol	Chain	Res	Type
1	F	423	ASN
3	L	71	THR
1	J	1092	ILE
2	I	788	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 53 such sidechains are listed below:

Mol	Chain	Res	Type
1	J	389	GLN
2	I	1116	ASN
4	G	86	ASN
1	J	491	ASN
1	J	1013	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](#)

There are no oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

8 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
5	FAR	N	1101	-	14,14,14	0.30	0	16,16,16	0.32	0
5	FAR	E	1301	-	14,14,14	2.28	3 (21%)	16,16,16	11.36	11 (68%)
5	FAR	F	1101	1	14,14,14	0.55	0	16,16,16	2.50	6 (37%)
5	FAR	A	1301	-	14,14,14	2.28	3 (21%)	16,16,16	11.44	11 (68%)
5	FAR	I	1301	2	14,14,14	2.30	3 (21%)	16,16,16	11.35	11 (68%)
5	FAR	B	1101	1	14,14,14	0.60	0	16,16,16	2.79	11 (68%)
5	FAR	M	1301	-	14,14,14	2.38	4 (28%)	16,16,16	12.33	11 (68%)
5	FAR	J	1101	-	14,14,14	2.08	4 (28%)	16,16,16	11.74	10 (62%)

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
5	FAR	N	1101	-	-	4/14/14/14	-
5	FAR	E	1301	-	-	4/14/14/14	-
5	FAR	F	1101	1	-	3/14/14/14	-
5	FAR	A	1301	-	-	5/14/14/14	-
5	FAR	I	1301	2	-	4/14/14/14	-
5	FAR	B	1101	1	-	5/14/14/14	-
5	FAR	M	1301	-	-	5/14/14/14	-
5	FAR	J	1101	-	-	4/14/14/14	-

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	M	1301	FAR	C5-C3	4.65	1.61	1.51
5	A	1301	FAR	C10-C8	4.50	1.62	1.50
5	I	1301	FAR	C10-C8	4.48	1.62	1.50
5	J	1101	FAR	C5-C3	4.44	1.60	1.51
5	E	1301	FAR	C10-C8	4.42	1.62	1.50

The worst 5 of 71 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	J	1101	FAR	C4-C3-C5	-27.41	69.16	115.27
5	M	1301	FAR	C4-C3-C5	-27.15	69.60	115.27
5	J	1101	FAR	C9-C8-C7	23.30	168.26	121.12

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	1301	FAR	C4-C3-C2	23.25	169.90	123.81
5	I	1301	FAR	C4-C3-C2	22.79	168.99	123.81

There are no chirality outliers.

5 of 34 torsion outliers are listed below:

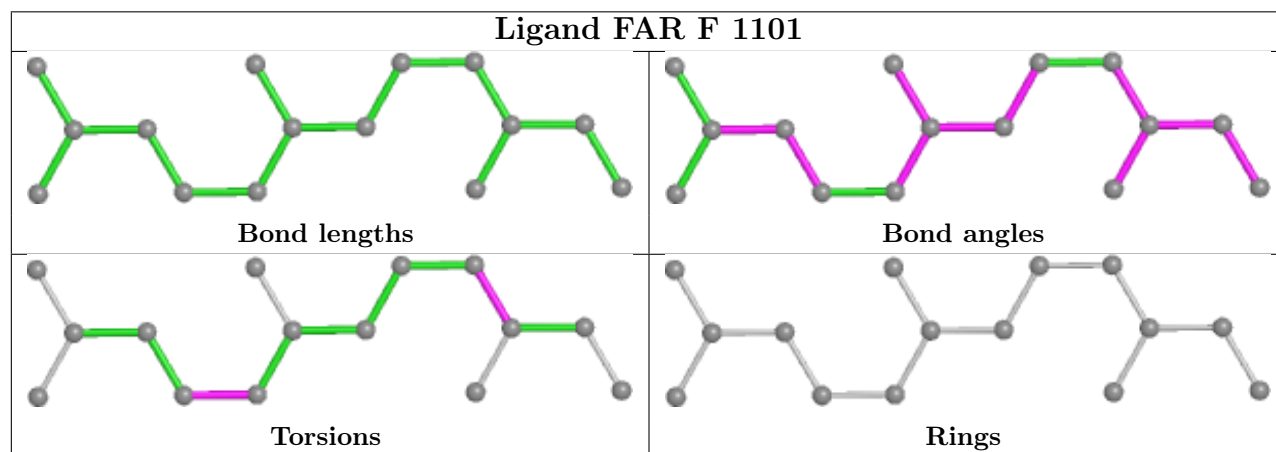
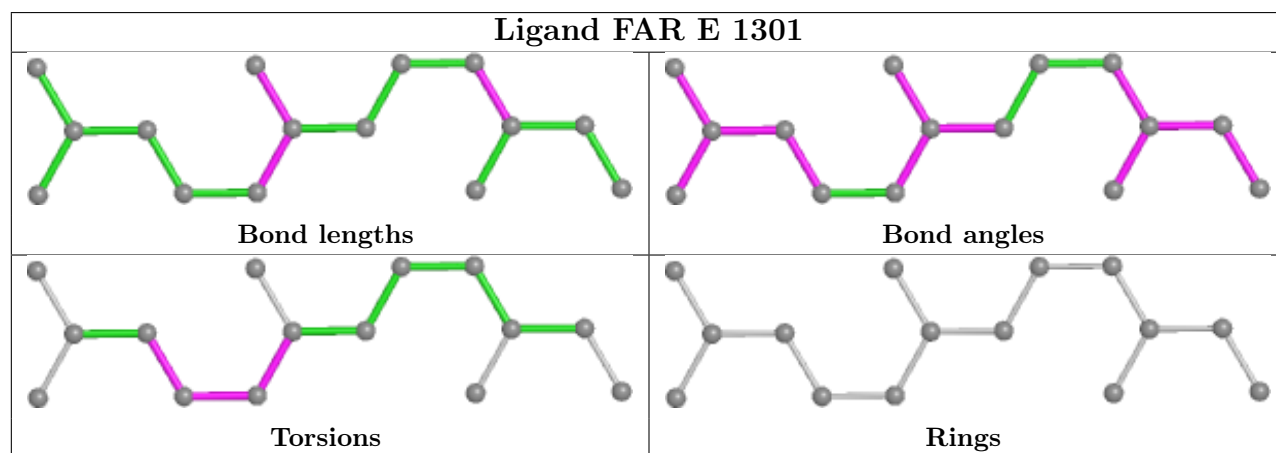
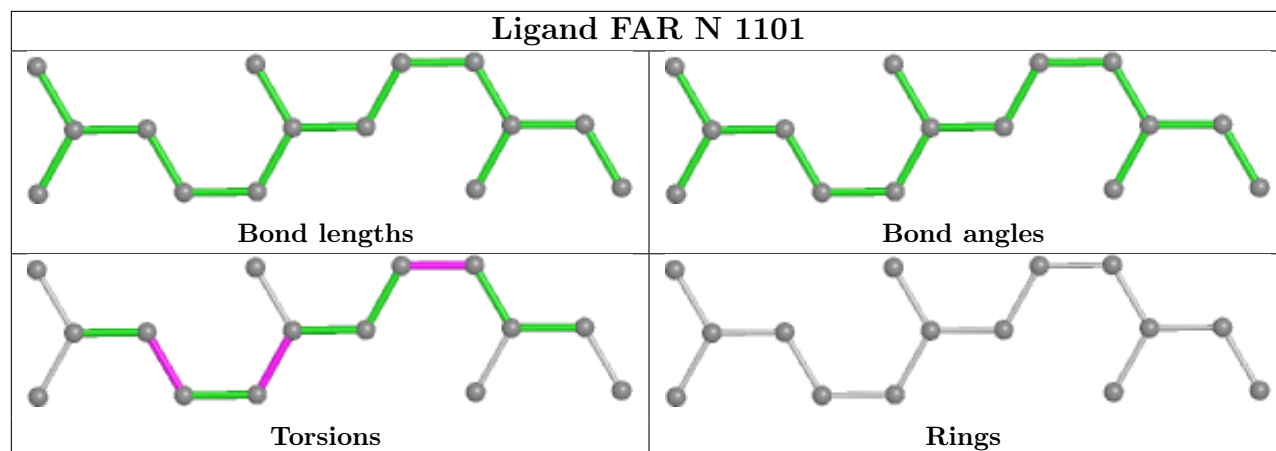
Mol	Chain	Res	Type	Atoms
5	B	1101	FAR	C5-C6-C7-C8
5	M	1301	FAR	C3-C5-C6-C7
5	M	1301	FAR	C12-C11-C9-C8
5	M	1301	FAR	C9-C11-C12-C13
5	A	1301	FAR	C9-C11-C12-C13

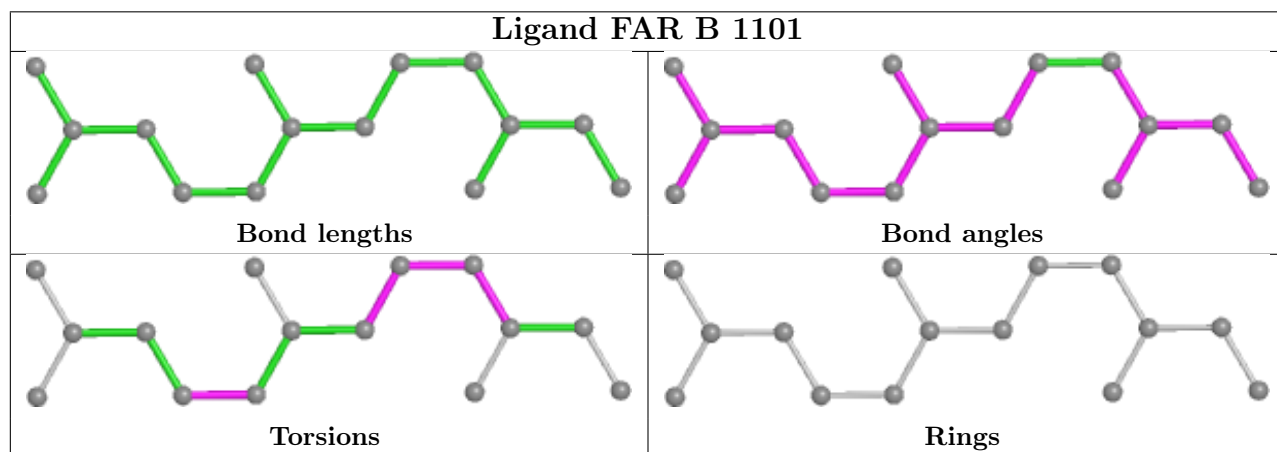
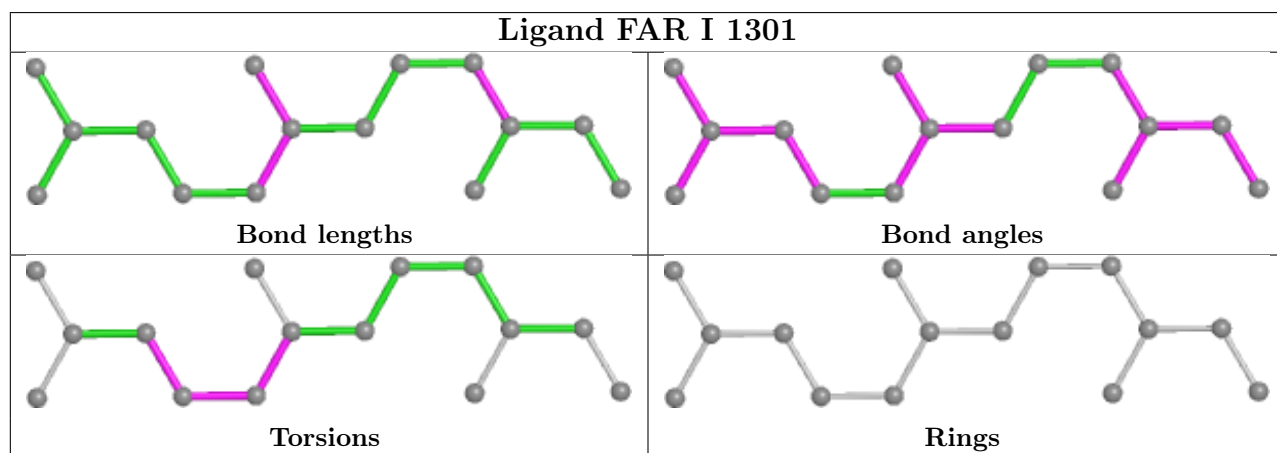
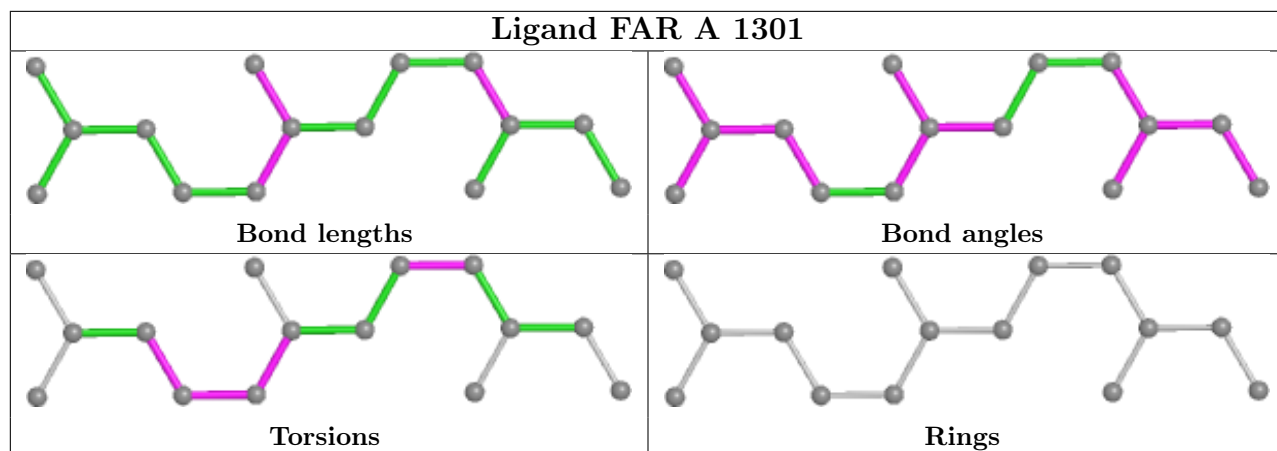
There are no ring outliers.

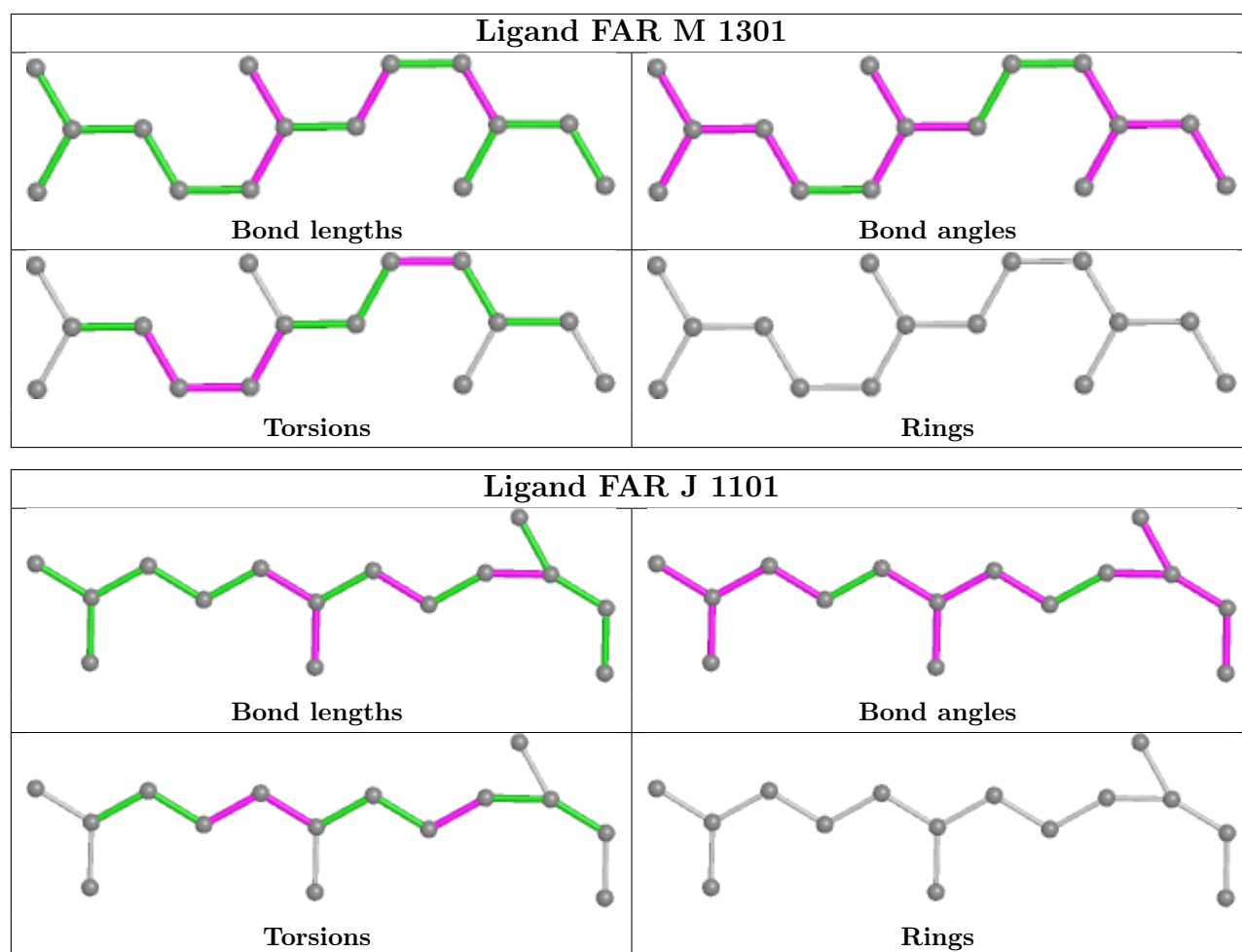
8 monomers are involved in 143 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	N	1101	FAR	16	0
5	E	1301	FAR	11	0
5	F	1101	FAR	28	0
5	A	1301	FAR	10	0
5	I	1301	FAR	9	0
5	B	1101	FAR	22	0
5	M	1301	FAR	5	0
5	J	1101	FAR	43	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 than 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.







## 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.