# Full wwPDB EM Validation Report

Mar 10, 2026 – 02:17 PM UTC

| | | |
|---|---|---|
| PDB ID | : | 5KHR / pdb_00005khr |
| EMDB ID | : | EMD-4025 |
| Title | : | Model of human Anaphase-promoting complex/Cyclosome complex (APC15 deletion mutant) in complex with the E2 UBE2C/UBCH10 poised for ubiquitin ligation to substrate (APC/C-CDC20-substrate-UBE2C) |
| Authors | : | VanderLinden, R.; Yamaguchi, M.; Dube, P.; Haselbach, D.; Stark, H.; Schulman, B.A. |
| Deposited on | : | 2016-06-15 |
| Resolution | : | 6.10 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 ⓘ 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:

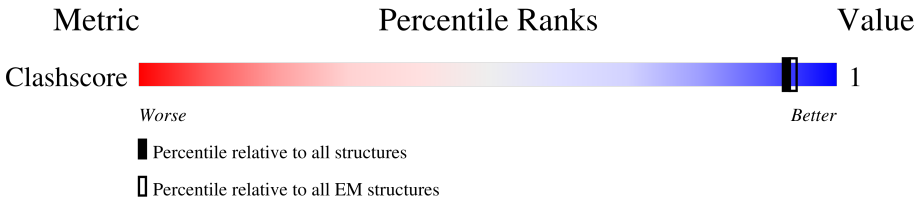
| | | |
|---|---|---|
| EMDB validation analysis | : | 0.0.1.dev132 |
| MolProbity | : | 4-5-2 with Phenix2.0 |
| Percentile statistics | : | 20250101.v01 (using entries in the PDB archive January 1st 2025) |
| EM percentile statistics | : | 202505.v01 (Using data in the EMDB archive up until May 2025) |
| MapQ | : | 1.9.13 |
| Ideal geometry (proteins) | : | Engh & Huber (2001) |
| Ideal geometry (DNA, RNA) | : | Parkinson et al. (1996) |
| Validation Pipeline (wwPDB-VP) | : | 2.49 |

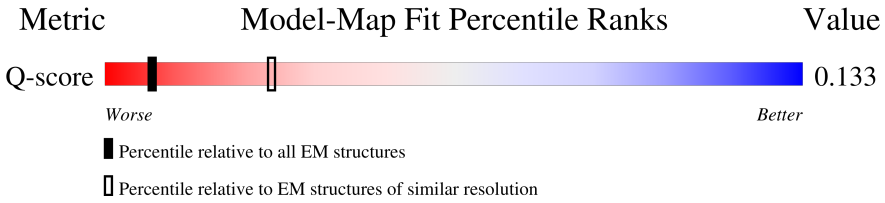
# 1 Overall quality at a glance

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

The reported resolution of this entry is 6.10 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) | Similar EM resolution (#Entries, resolution range(Å)) |
|---|---|---|---|
| Clashscore | 229148 | 23984 | - |
| Q-score | - | 25397 | 531 ( 5.60 - 6.60 ) |

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% The upper red bar (where present) indicates the fraction of residues that have poor fit to the EM map (all-atom inclusion < 40%). The numeric value is given above the bar.

| Mol | Chain | Length | Quality of chain |
|---|---|---|---|
| 1 | A | 1944 | 9% 71% 28% |
| 2 | B | 84 | 18% 82% 18% |
| 3 | C | 597 | 12% 78% 22% |
| 3 | P | 597 | 5% 74% 26% |
| 4 | E | 110 | 51% 49% |
| 5 | F | 824 | 58% 42% |

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| Mol | Chain | Length | Quality of chain |
|---|---|---|---|
| 5 | H | 824 | 59% 41% |
| 6 | G | 85 | 9% 29% 71% |
| 6 | W | 85 | 5% 29% 71% |
| 7 | I | 818 | 6% 84% 15% |
| 8 | J | 620 | 7% 81% 19% |
| 8 | K | 620 | 6% 80% 20% |
| 9 | L | 185 | 13% 93% 6% |
| 10 | M | 74 | 18% 64% 36% |
| 11 | N | 822 | 19% 77% 22% |
| 12 | O | 755 | 8% 80% 20% |
| 13 | Q | 190 | 27% 76% 24% |
| 14 | R | 499 | 16% 73% 26% |
| 15 | S | 33 | 12% 30% 70% |
| 16 | X | 565 | 8% 70% 30% |
| 16 | Y | 565 | 8% 73% 27% |

## 2 Entry composition (i)

There are 16 unique types of molecules in this entry. The entry contains 7936 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 Anaphase-promoting complex subunit 1.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 1 | A | 1391 | Total C<br>1391 1391 | 0 | 1391 |

- Molecule 2 is a protein called Anaphase-promoting complex subunit 11.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 2 | B | 69 | Total C<br>70 70 | 1 | 69 |

- Molecule 3 is a protein called Cell division cycle protein 23 homolog.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 3 | C | 468 | Total C<br>468 468 | 0 | 468 |
| 3 | P | 441 | Total C<br>441 441 | 0 | 441 |

- Molecule 4 is a protein called Anaphase-promoting complex subunit 16.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 4 | E | 56 | Total C<br>56 56 | 0 | 56 |

- Molecule 5 is a protein called Cell division cycle protein 27 homolog.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 5 | F | 481 | Total C<br>481 481 | 0 | 481 |
| 5 | H | 483 | Total C<br>483 483 | 0 | 483 |

- Molecule 6 is a protein called Anaphase-promoting complex subunit CDC26.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 6 | G | 25 | Total C<br>25 25 | 0 | 25 |
| 6 | W | 25 | Total C<br>25 25 | 0 | 25 |

- Molecule 7 is a protein called Anaphase-promoting complex subunit 4.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 7 | I | 693 | Total C<br>693 693 | 0 | 693 |

There are 10 discrepancies between the modelled and reference sequences:

| Chain | Residue | Modelled | Actual | Comment | Reference |
|---|---|---|---|---|---|
| I | 809 | GLY | - | expression tag | UNP Q9UJX5 |
| I | 810 | GLY | - | expression tag | UNP Q9UJX5 |
| I | 811 | SER | - | expression tag | UNP Q9UJX5 |
| I | 812 | LEU | - | expression tag | UNP Q9UJX5 |
| I | 813 | GLU | - | expression tag | UNP Q9UJX5 |
| I | 814 | VAL | - | expression tag | UNP Q9UJX5 |
| I | 815 | LEU | - | expression tag | UNP Q9UJX5 |
| I | 816 | PHE | - | expression tag | UNP Q9UJX5 |
| I | 817 | GLN | - | expression tag | UNP Q9UJX5 |
| I | 818 | GLY | - | expression tag | UNP Q9UJX5 |

- Molecule 8 is a protein called Cell division cycle protein 16 homolog.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 8 | J | 504 | Total C<br>504 504 | 0 | 504 |
| 8 | K | 493 | Total C<br>493 493 | 0 | 493 |

- Molecule 9 is a protein called Anaphase-promoting complex subunit 10.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 9 | L | 174 | Total C<br>174 174 | 0 | 174 |

- Molecule 10 is a protein called Anaphase-promoting complex subunit 13.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 10 | M | 47 | Total C<br>47 47 | 0 | 47 |

- Molecule 11 is a protein called Anaphase-promoting complex subunit 2.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 11 | N | 645 | Total C<br>645 645 | 0 | 645 |

There are 2 discrepancies between the modelled and reference sequences:

| Chain | Residue | Modelled | Actual | Comment | Reference |
|---|---|---|---|---|---|
| N | 534 | GLU | SER | engineered mutation | UNP Q9UJX6 |
| N | 811 | GLU | SER | engineered mutation | UNP Q9UJX6 |

- Molecule 12 is a protein called Anaphase-promoting complex subunit 5.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 12 | O | 603 | Total C<br>603 603 | 0 | 603 |

There are 2 discrepancies between the modelled and reference sequences:

| Chain | Residue | Modelled | Actual | Comment | Reference |
|---|---|---|---|---|---|
| O | 221 | GLU | SER | engineered mutation | UNP Q9UJX4 |
| O | 232 | GLU | THR | engineered mutation | UNP Q9UJX4 |

- Molecule 13 is a protein called Ubiquitin-conjugating enzyme E2 C.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 13 | Q | 145 | Total C<br>146 146 | 1 | 145 |

There are 11 discrepancies between the modelled and reference sequences:

| Chain | Residue | Modelled | Actual | Comment | Reference |
|---|---|---|---|---|---|
| Q | 180 | GLY | - | expression tag | UNP O00762 |
| Q | 181 | GLY | - | expression tag | UNP O00762 |
| Q | 182 | SER | - | expression tag | UNP O00762 |
| Q | 183 | GLY | - | expression tag | UNP O00762 |
| Q | 184 | SER | - | expression tag | UNP O00762 |
| Q | 185 | LEU | - | expression tag | UNP O00762 |

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| Chain | Residue | Modelled | Actual | Comment | Reference |
|---|---|---|---|---|---|
| Q | 186 | GLU | - | expression tag | UNP O00762 |
| Q | 187 | VAL | - | expression tag | UNP O00762 |
| Q | 188 | LEU | - | expression tag | UNP O00762 |
| Q | 189 | PHE | - | expression tag | UNP O00762 |
| Q | 190 | GLN | - | expression tag | UNP O00762 |

- Molecule 14 is a protein called Cell division cycle protein 20 homolog.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 14 | R | 368 | Total C<br>370 370 | 2 | 368 |

- Molecule 15 is a protein called HSL1 peptide.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 15 | S | 10 | Total C<br>10 10 | 0 | 10 |

- Molecule 16 is a protein called Anaphase-promoting complex subunit 7.

| Mol | Chain | Residues | Atoms | AltConf | Trace |
|---|---|---|---|---|---|
| 16 | X | 396 | Total C<br>396 396 | 0 | 396 |
| 16 | Y | 415 | Total C<br>415 415 | 0 | 415 |

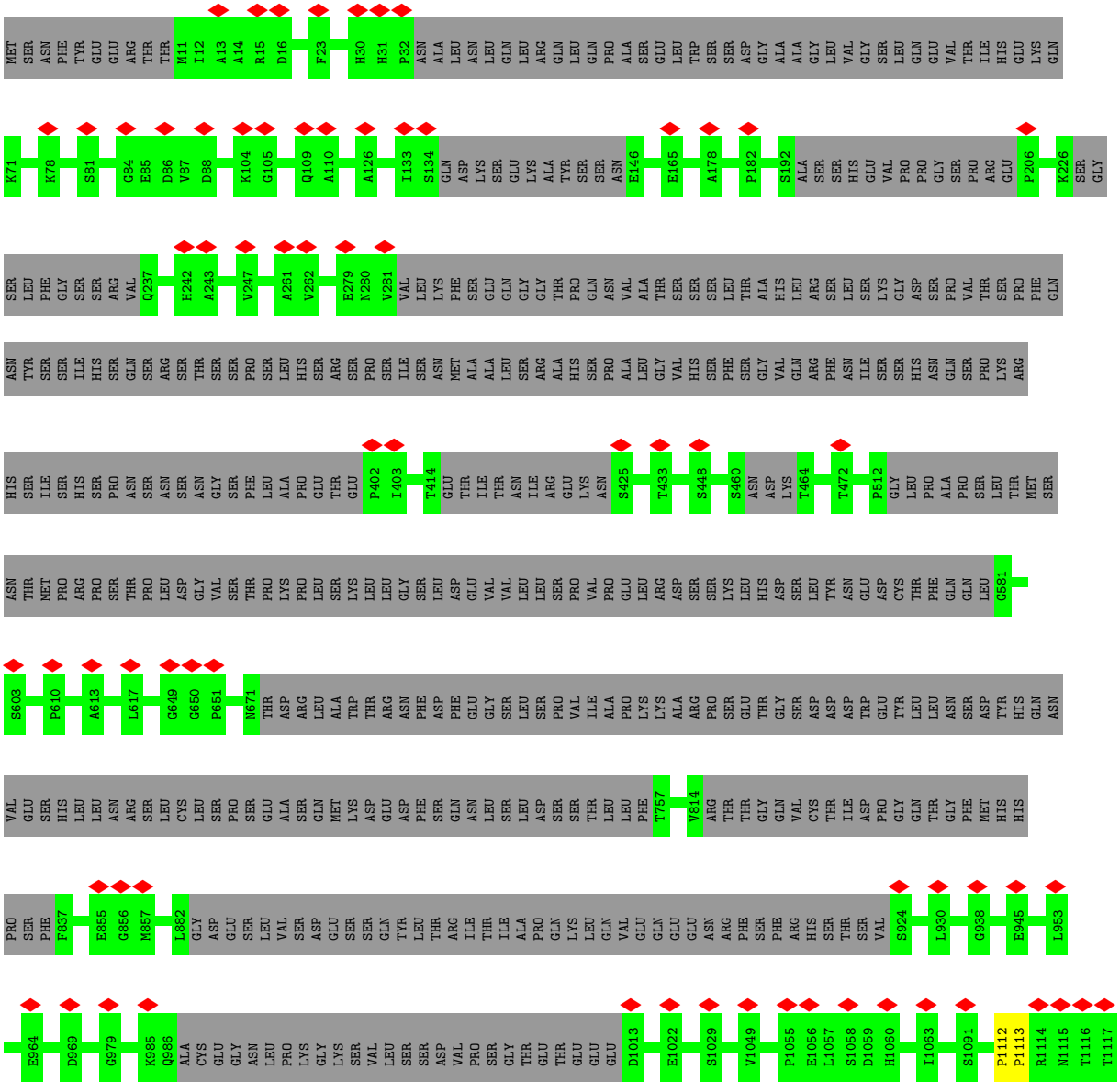
# 3 Residue-property plots (i)

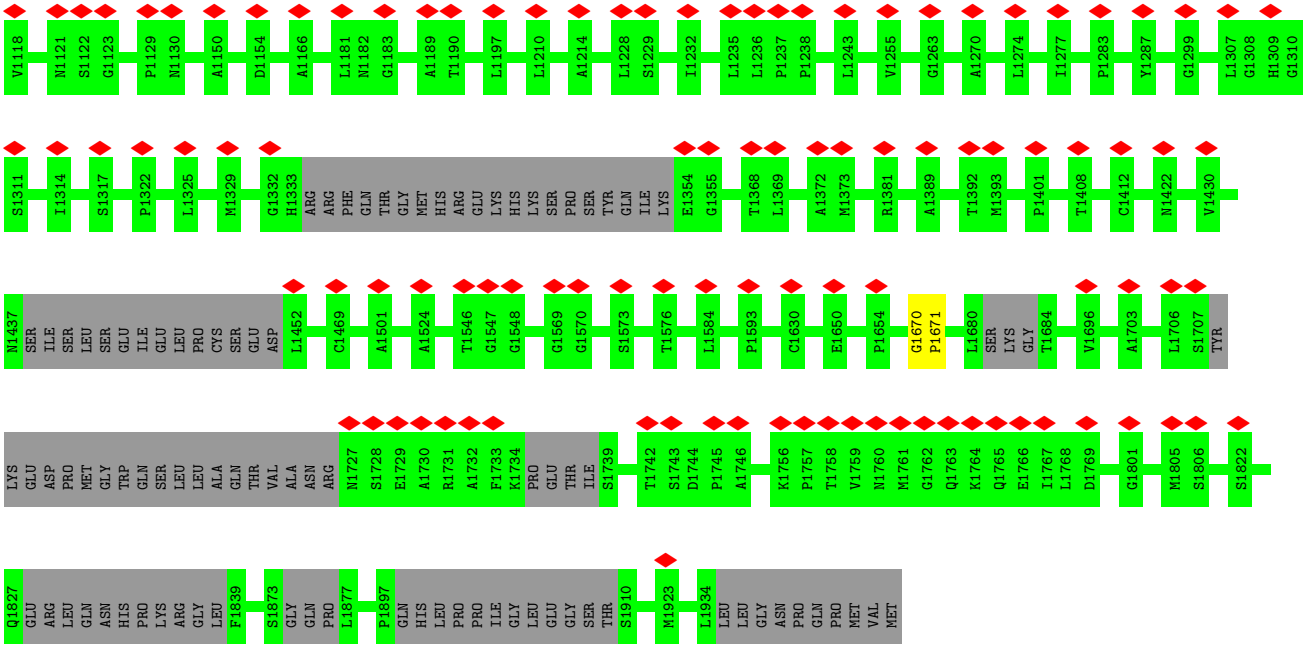
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and atom inclusion in map 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 diamond above a residue indicates a poor fit to the EM map for this residue (all-atom inclusion < 40%). 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: Anaphase-promoting complex subunit 1

Chain A:



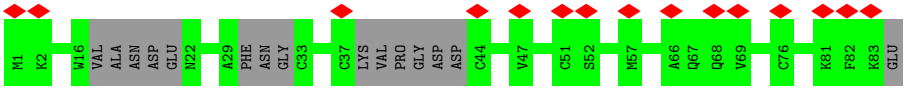





• Molecule 2: Anaphase-promoting complex subunit 11

Chain B:

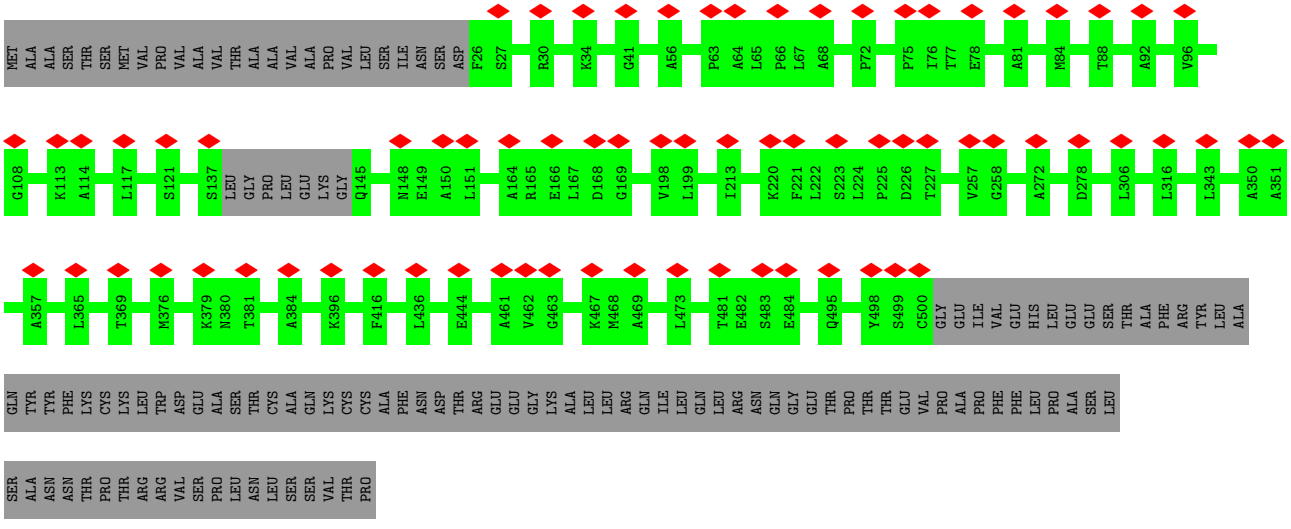


• Molecule 3: Cell division cycle protein 23 homolog

Chain C:

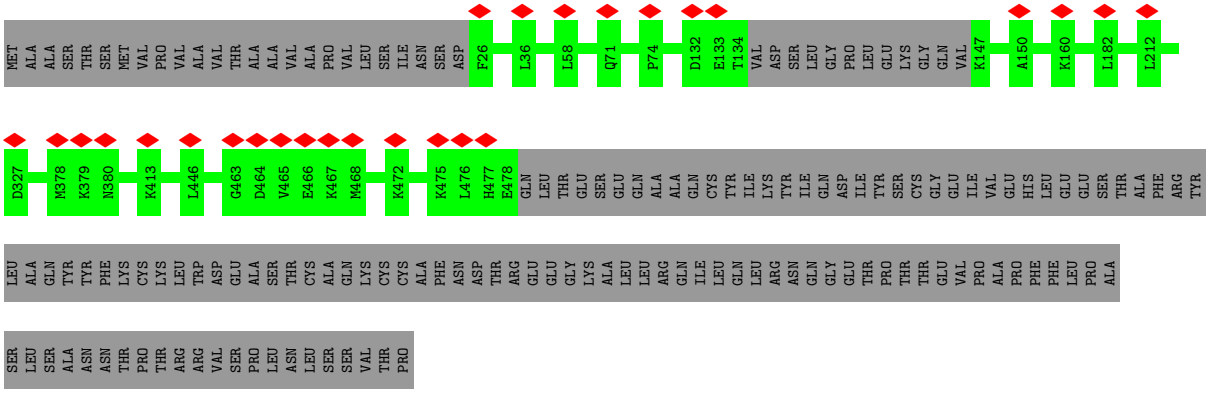


• Molecule 3: Cell division cycle protein 23 homolog

Chain P:

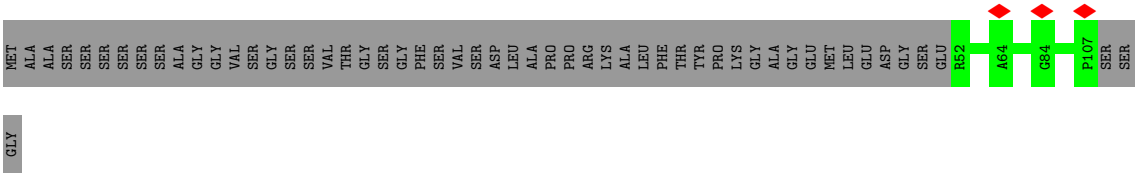





• Molecule 4: Anaphase-promoting complex subunit 16

Chain E:

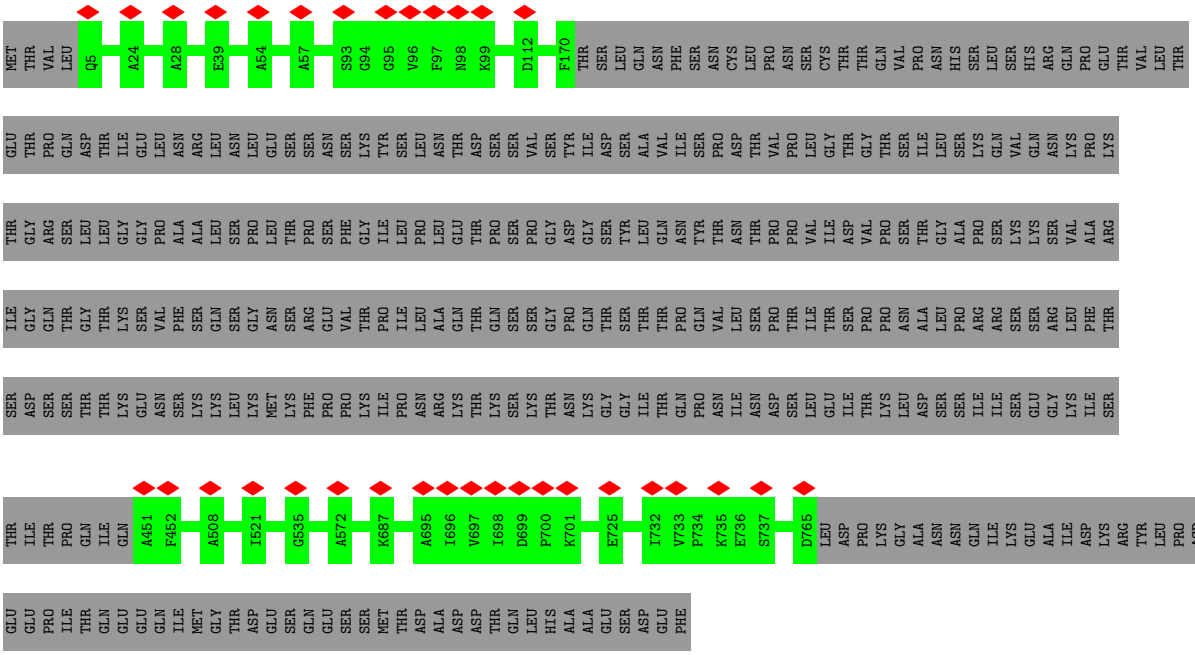



• Molecule 5: Cell division cycle protein 27 homolog

Chain F:

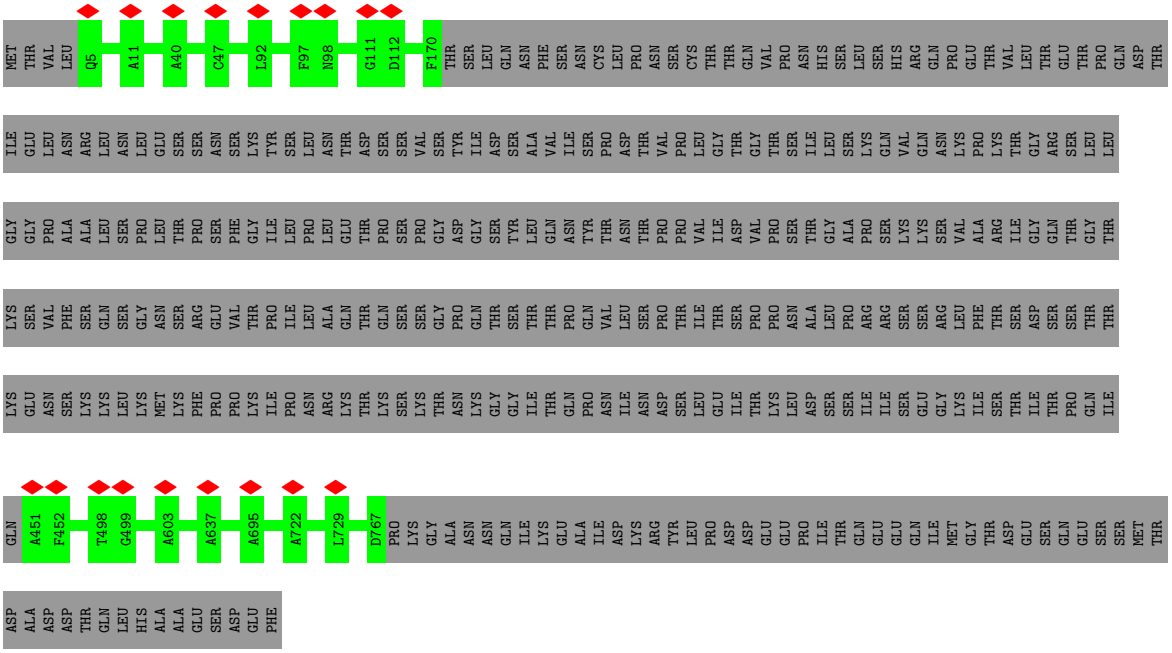



• Molecule 5: Cell division cycle protein 27 homolog

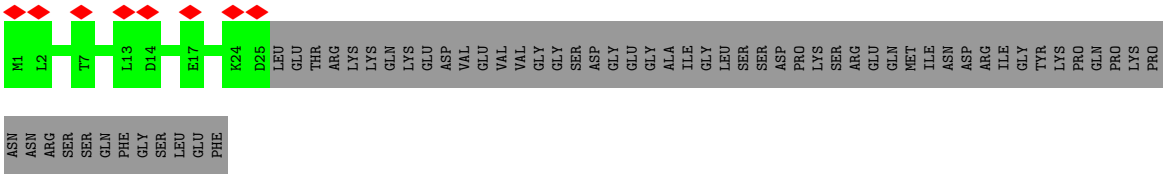
Chain H:





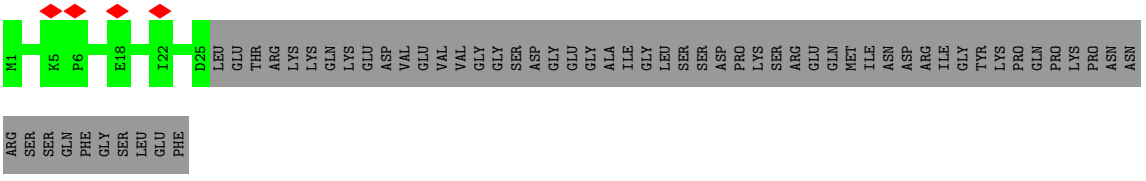

• Molecule 6: Anaphase-promoting complex subunit CDC26



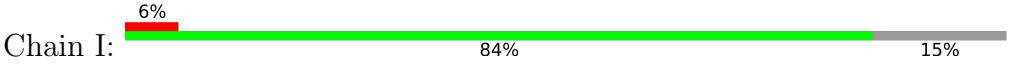



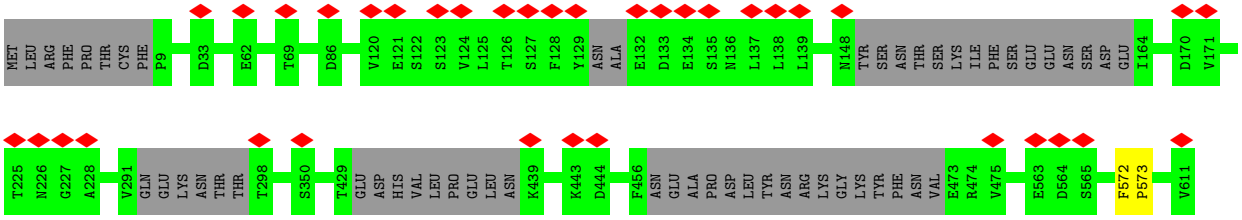

• Molecule 6: Anaphase-promoting complex subunit CDC26

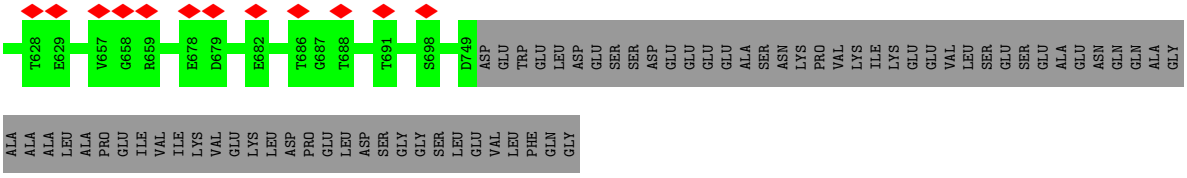



• Molecule 7: Anaphase-promoting complex subunit 4



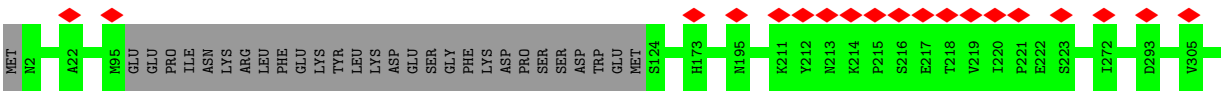


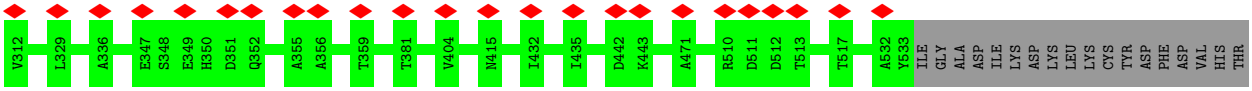


• Molecule 8: Cell division cycle protein 16 homolog

Chain J:





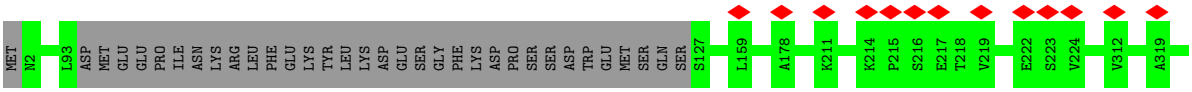


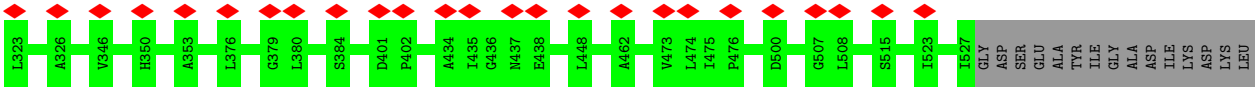


• Molecule 8: Cell division cycle protein 16 homolog

Chain K:



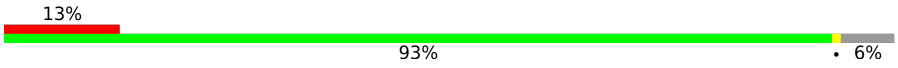


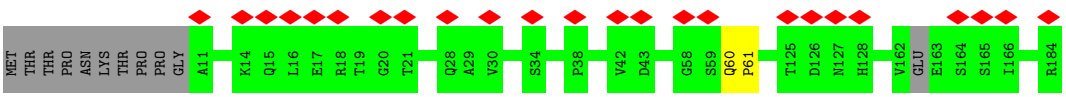




• Molecule 9: Anaphase-promoting complex subunit 10

Chain L:

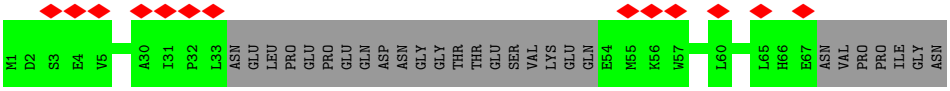


• Molecule 10: Anaphase-promoting complex subunit 13

Chain M:

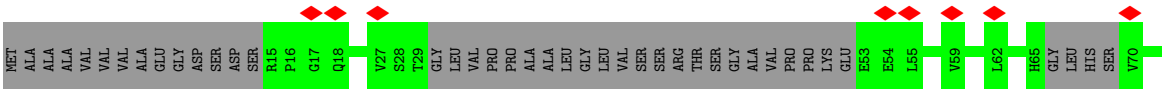


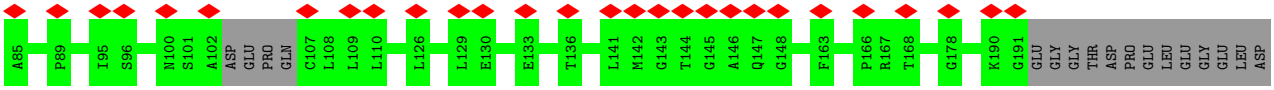


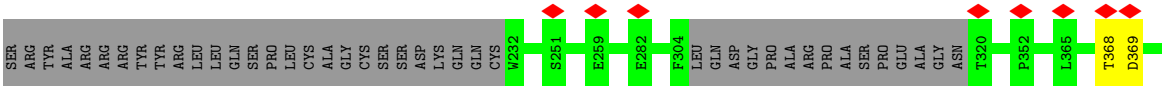
• Molecule 11: Anaphase-promoting complex subunit 2

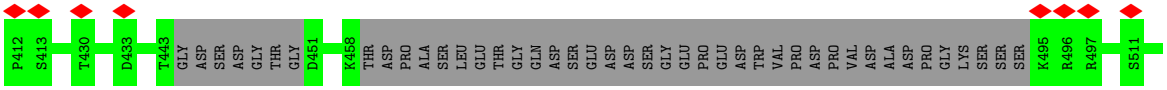
Chain N:

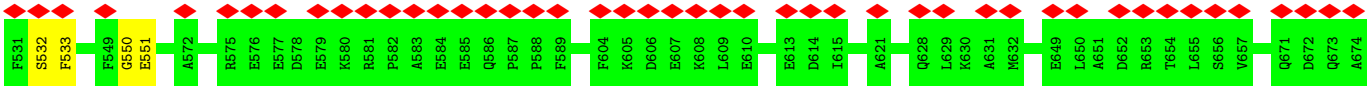


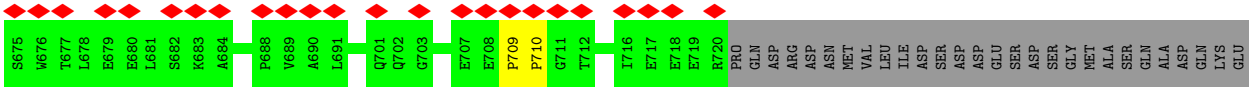



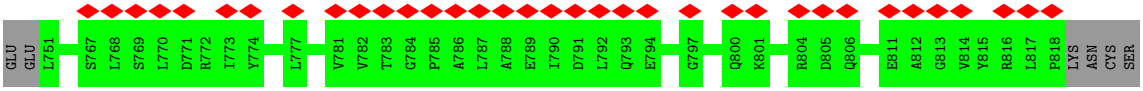








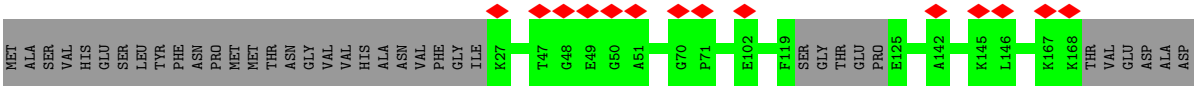


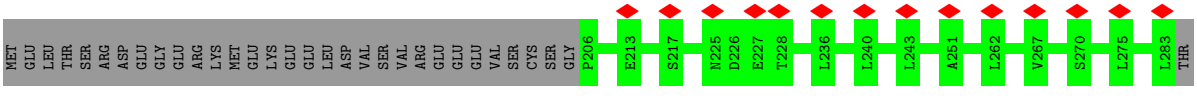


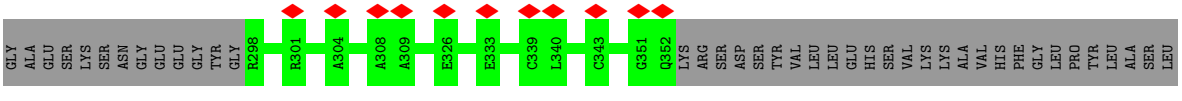
• Molecule 12: Anaphase-promoting complex subunit 5

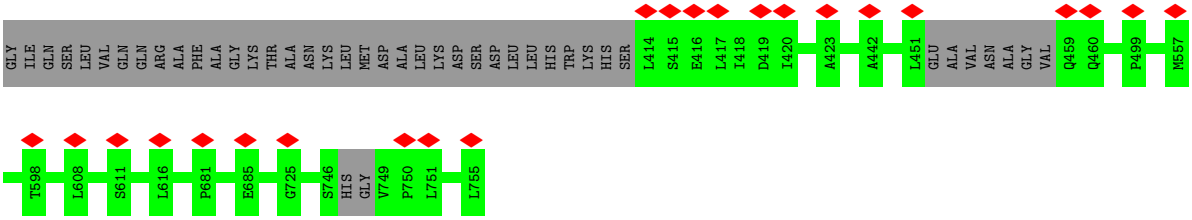
Chain O:





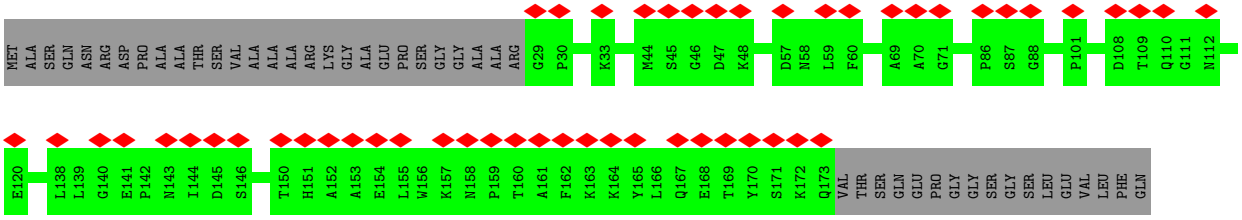




• Molecule 13: Ubiquitin-conjugating enzyme E2 C

Chain Q:

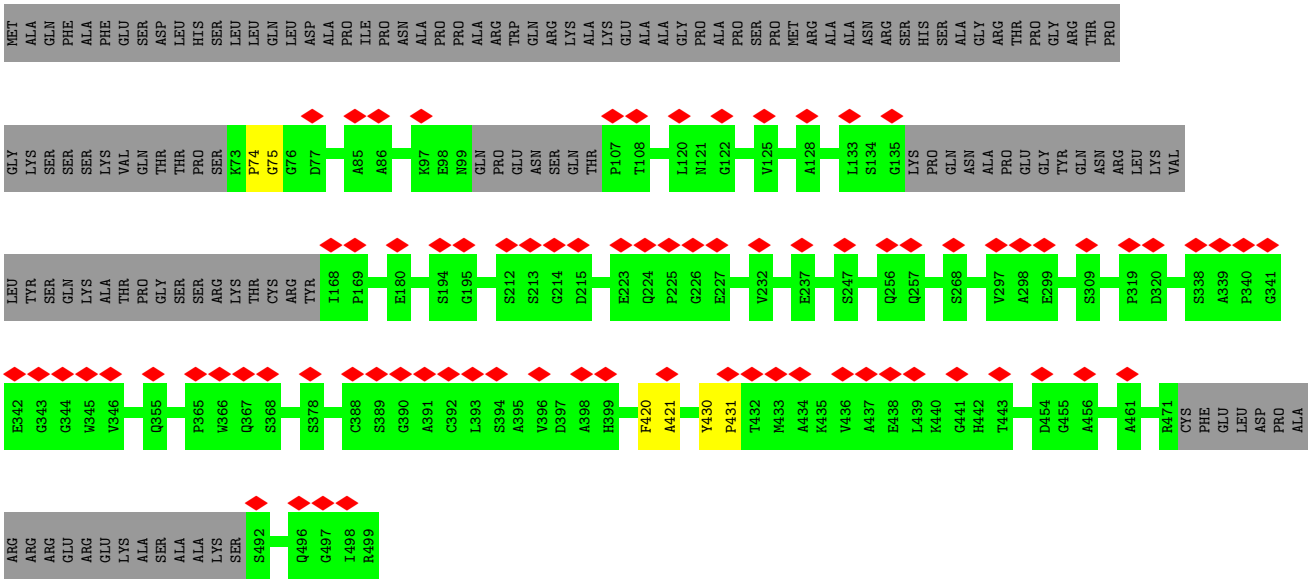


• Molecule 14: Cell division cycle protein 20 homolog

Chain R:

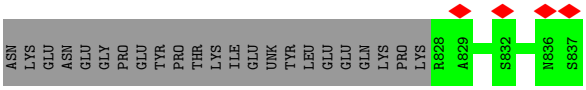


• Molecule 15: HSL1 peptide

Chain S:

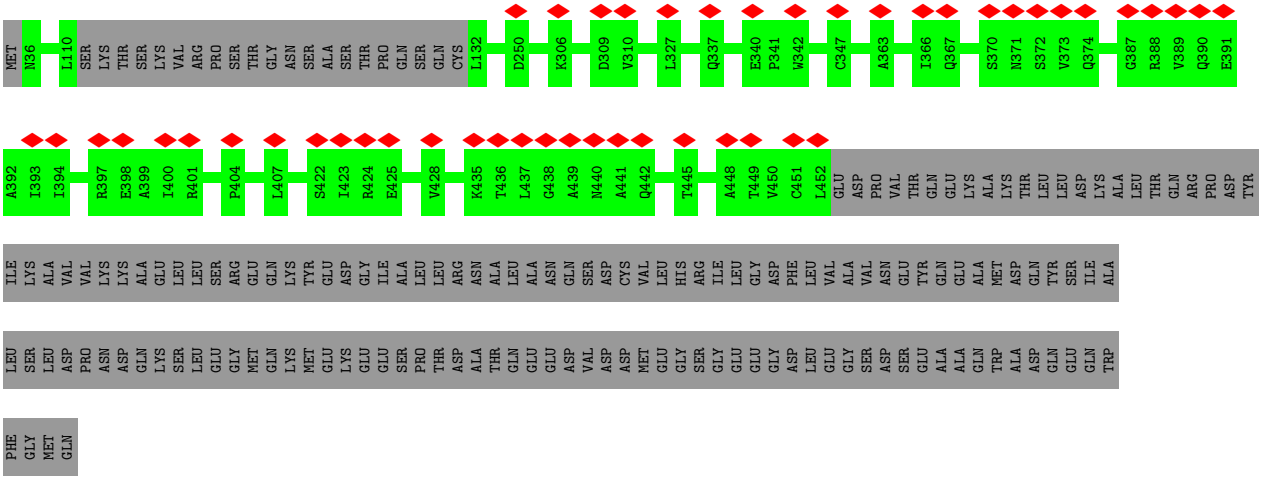


• Molecule 16: Anaphase-promoting complex subunit 7

Chain X:

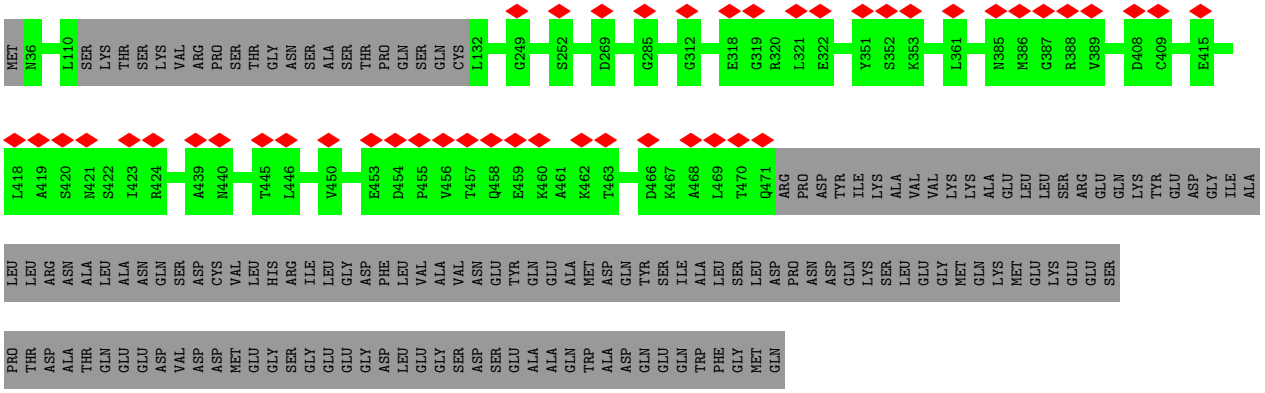





• Molecule 16: Anaphase-promoting complex subunit 7

Chain Y:



# 4 Experimental information (i)

| Property | Value | Source |
|---|---|---|
| EM reconstruction method | SINGLE PARTICLE | Depositor |
| Imposed symmetry | POINT, Not provided | |
| Number of particles used | 222697 | Depositor |
| Resolution determination method | FSC 0.143 CUT-OFF | Depositor |
| CTF correction method | PHASE FLIPPING AND AMPLITUDE CORRECTION | Depositor |
| Microscope | FEI TITAN KRIOS | Depositor |
| Voltage (kV) | 300 | Depositor |
| Electron dose ($e^-/Å^2$) | 40 | Depositor |
| Minimum defocus (nm) | Not provided | |
| Maximum defocus (nm) | Not provided | |
| Magnification | Not provided | |
| Image detector | FEI FALCON II (4k x 4k) | Depositor |
| Maximum map value | 0.317 | Depositor |
| Minimum map value | -0.138 | Depositor |
| Average map value | 0.000 | Depositor |
| Map value standard deviation | 0.017 | Depositor |
| Recommended contour level | 0.081 | Depositor |
| Map size (Å) | 401.92, 401.92, 401.92 | wwPDB |
| Map dimensions | 256, 256, 256 | wwPDB |
| Map angles (°) | 90.0, 90.0, 90.0 | wwPDB |
| Pixel spacing (Å) | 1.57, 1.57, 1.57 | Depositor |

# 5 Model quality

## 5.1 Standard geometry

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).

There are no protein, RNA or DNA chains available to summarize Z scores of covalent bonds and angles.

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 | 1391 | 0 | 0 | 2 | 0 |
| 2 | B | 70 | 0 | 0 | 0 | 0 |
| 3 | C | 468 | 0 | 0 | 0 | 0 |
| 3 | P | 441 | 0 | 0 | 0 | 0 |
| 4 | E | 56 | 0 | 0 | 0 | 0 |
| 5 | F | 481 | 0 | 0 | 0 | 0 |
| 5 | H | 483 | 0 | 0 | 0 | 0 |
| 6 | G | 25 | 0 | 0 | 0 | 0 |
| 6 | W | 25 | 0 | 0 | 0 | 0 |
| 7 | I | 693 | 0 | 0 | 1 | 0 |
| 8 | J | 504 | 0 | 0 | 0 | 0 |
| 8 | K | 493 | 0 | 0 | 0 | 0 |
| 9 | L | 174 | 0 | 0 | 1 | 0 |
| 10 | M | 47 | 0 | 0 | 0 | 0 |
| 11 | N | 645 | 0 | 0 | 4 | 0 |
| 12 | O | 603 | 0 | 0 | 0 | 0 |
| 13 | Q | 146 | 0 | 0 | 0 | 0 |
| 14 | R | 370 | 0 | 0 | 3 | 0 |

*Continued on next page...*

*Continued from previous page...*

| Mol | Chain | Non-H | H(model) | H(added) | Clashes | Symm-Clashes |
|---|---|---|---|---|---|---|
| 15 | S | 10 | 0 | 0 | 0 | 0 |
| 16 | X | 396 | 0 | 0 | 0 | 0 |
| 16 | Y | 415 | 0 | 0 | 0 | 0 |
| All | All | 7936 | 0 | 0 | 11 | 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 (11) 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) |
|---|---|---|---|
| 11:N:532:SER:CA | 11:N:533:PHE:CA | 2.83 | 0.56 |
| 1:A:1670:GLY:CA | 1:A:1671:PRO:CA | 2.84 | 0.55 |
| 11:N:550:GLY:CA | 11:N:551:GLU:CA | 2.85 | 0.55 |
| 11:N:368:THR:CA | 11:N:369:ASP:CA | 2.90 | 0.49 |
| 14:R:420:PHE:CA | 14:R:421:ALA:CA | 2.92 | 0.48 |
| 9:L:60:GLN:CA | 9:L:61:PRO:CA | 2.92 | 0.48 |
| 14:R:430:TYR:CA | 14:R:431:PRO:CA | 2.92 | 0.48 |
| 1:A:1112:PRO:CA | 1:A:1113:PRO:CA | 2.94 | 0.45 |
| 11:N:709:PRO:CA | 11:N:710:PRO:CA | 2.96 | 0.44 |
| 14:R:74:PRO:CA | 14:R:75:GLY:CA | 2.98 | 0.41 |
| 7:I:572:PHE:CA | 7:I:573:PRO:CA | 2.98 | 0.41 |

There are no symmetry-related clashes.

## 5.3 Torsion angles (i)

### 5.3.1 Protein backbone (i)

There are no protein backbone outliers to report in this entry.

### 5.3.2 Protein sidechains (i)

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

### 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)

There are no ligands in this entry.

## 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.

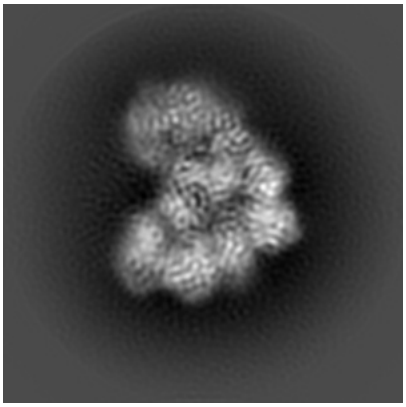
# 6 Map visualisation

This section contains visualisations of the EMDB entry EMD-4025. These allow visual inspection of the internal detail of the map and identification of artifacts.

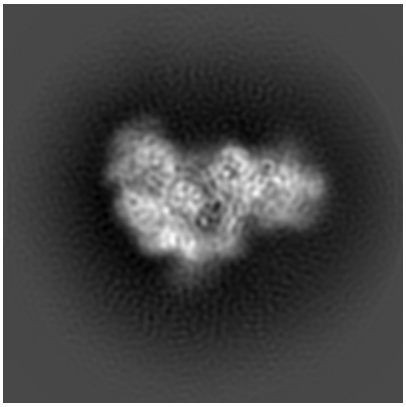
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

## 6.1 Orthogonal projections

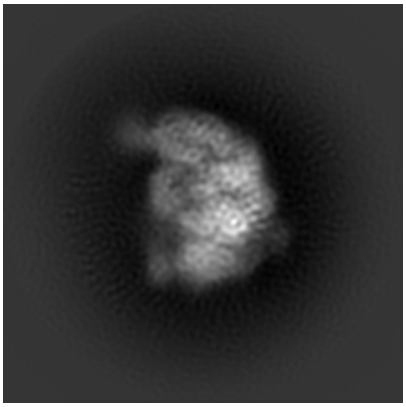
### 6.1.1 Primary map



X



Y

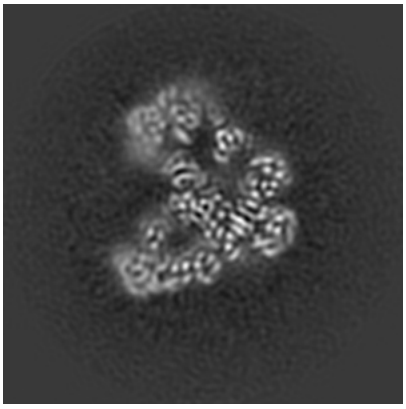


Z

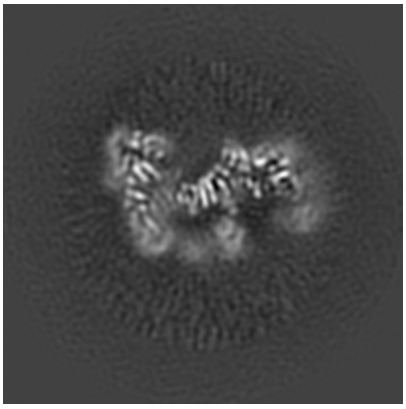
The images above show the map projected in three orthogonal directions.

## 6.2 Central slices

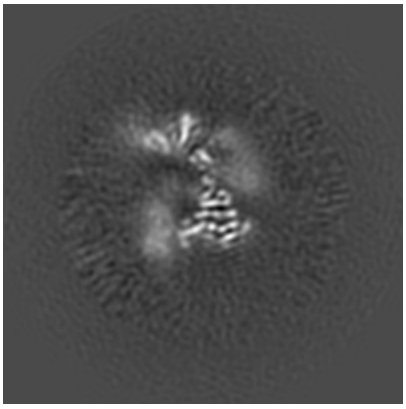
### 6.2.1 Primary map



X Index: 128



Y Index: 128

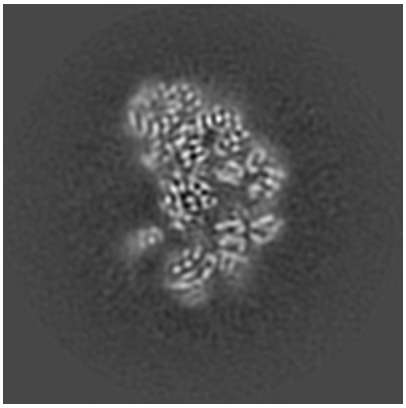


Z Index: 128

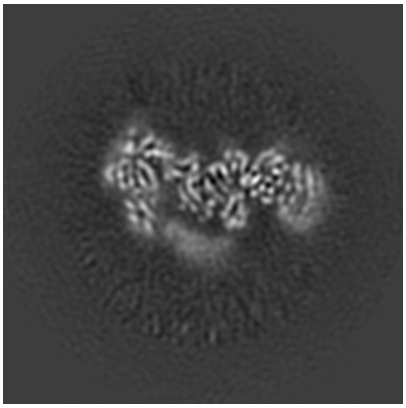
The images above show central slices of the map in three orthogonal directions.

## 6.3 Largest variance slices (i)

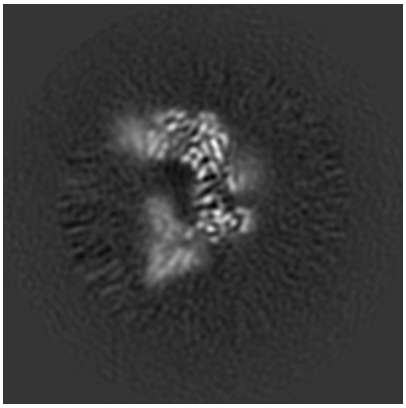
### 6.3.1 Primary map



X Index: 141



Y Index: 118

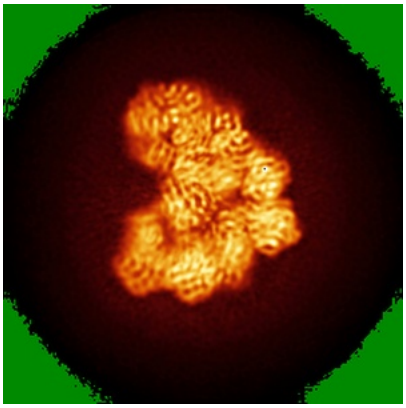


Z Index: 119

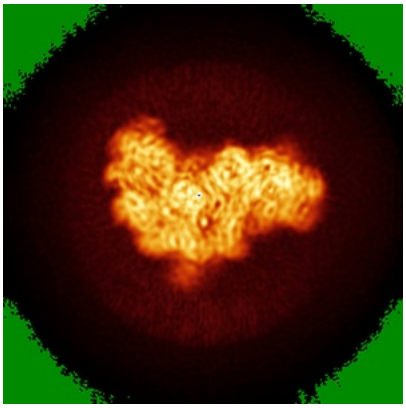
The images above show the largest variance slices of the map in three orthogonal directions.

## 6.4 Orthogonal standard-deviation projections (False-color) (i)

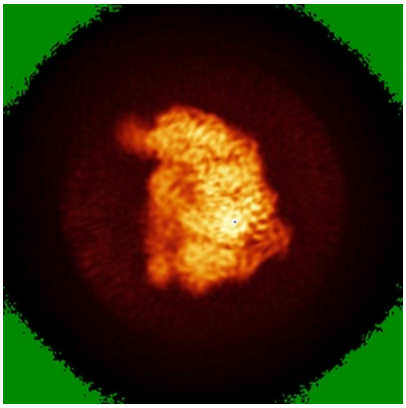
### 6.4.1 Primary map



X



Y



Z

The images above show the map standard deviation projections with false color in three orthogonal directions. Minimum values are shown in green, max in blue, and dark to light orange shades represent small to large values respectively.

## 6.5 Orthogonal surface views (i)

### 6.5.1 Primary map



X Y Z

The images above show the 3D surface view of the map at the recommended contour level 0.081. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

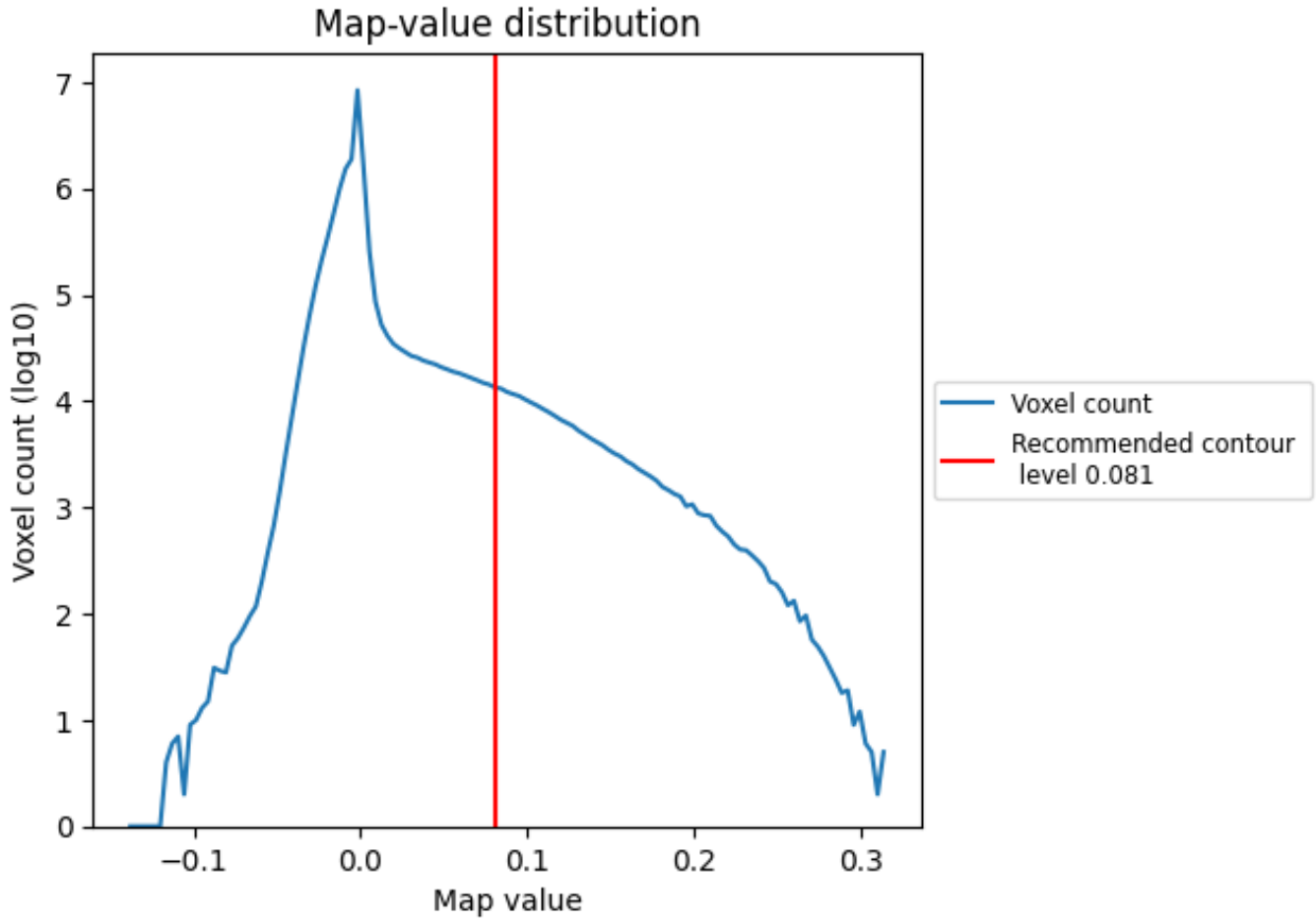
## 6.6 Mask visualisation (i)

This section was not generated. No masks/segmentation were deposited.

# 7 Map analysis

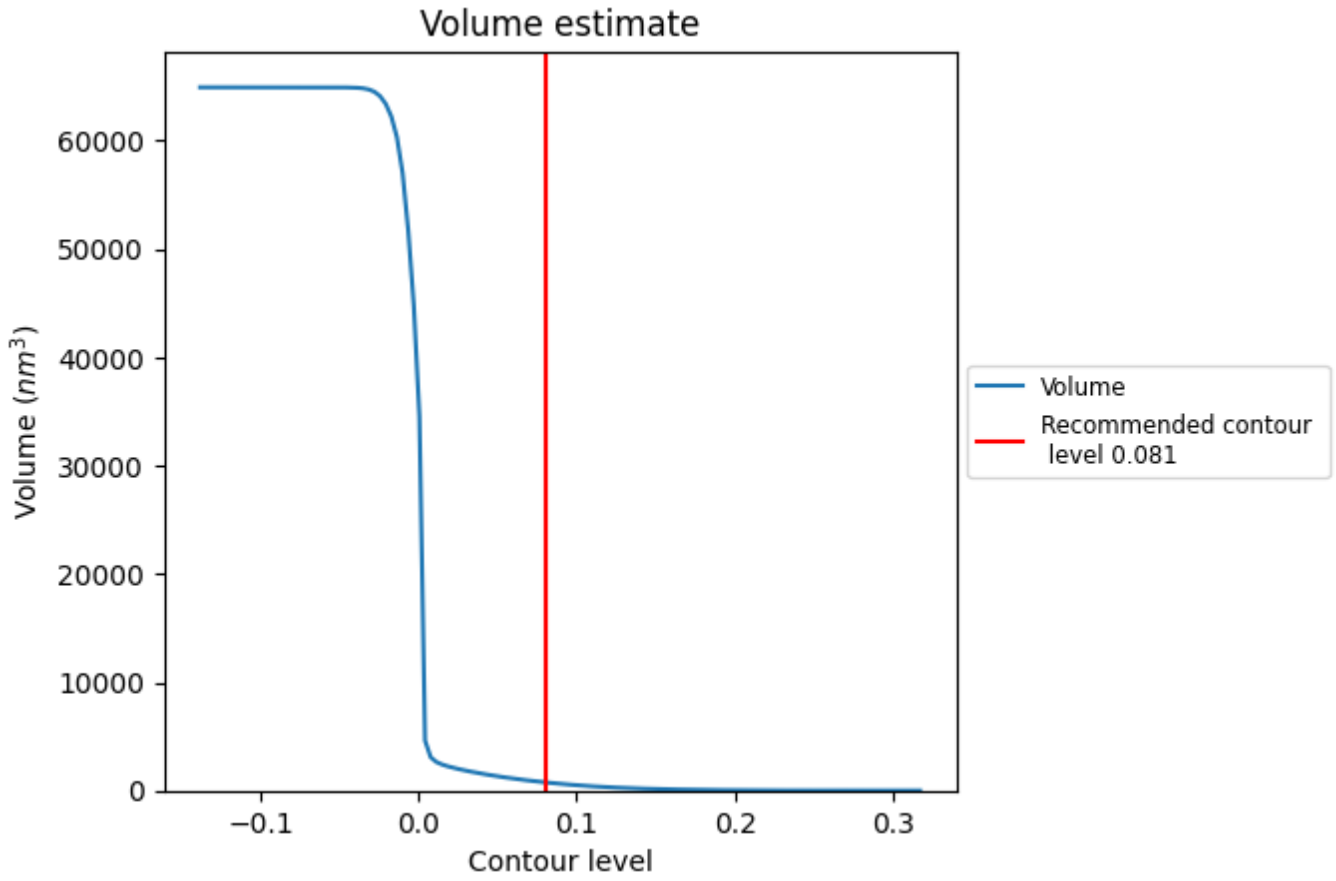
This section contains the results of statistical analysis of the map.

## 7.1 Map-value distribution




The map-value distribution is plotted in 128 intervals along the x-axis. The y-axis is logarithmic. A spike in this graph at zero usually indicates that the volume has been masked.

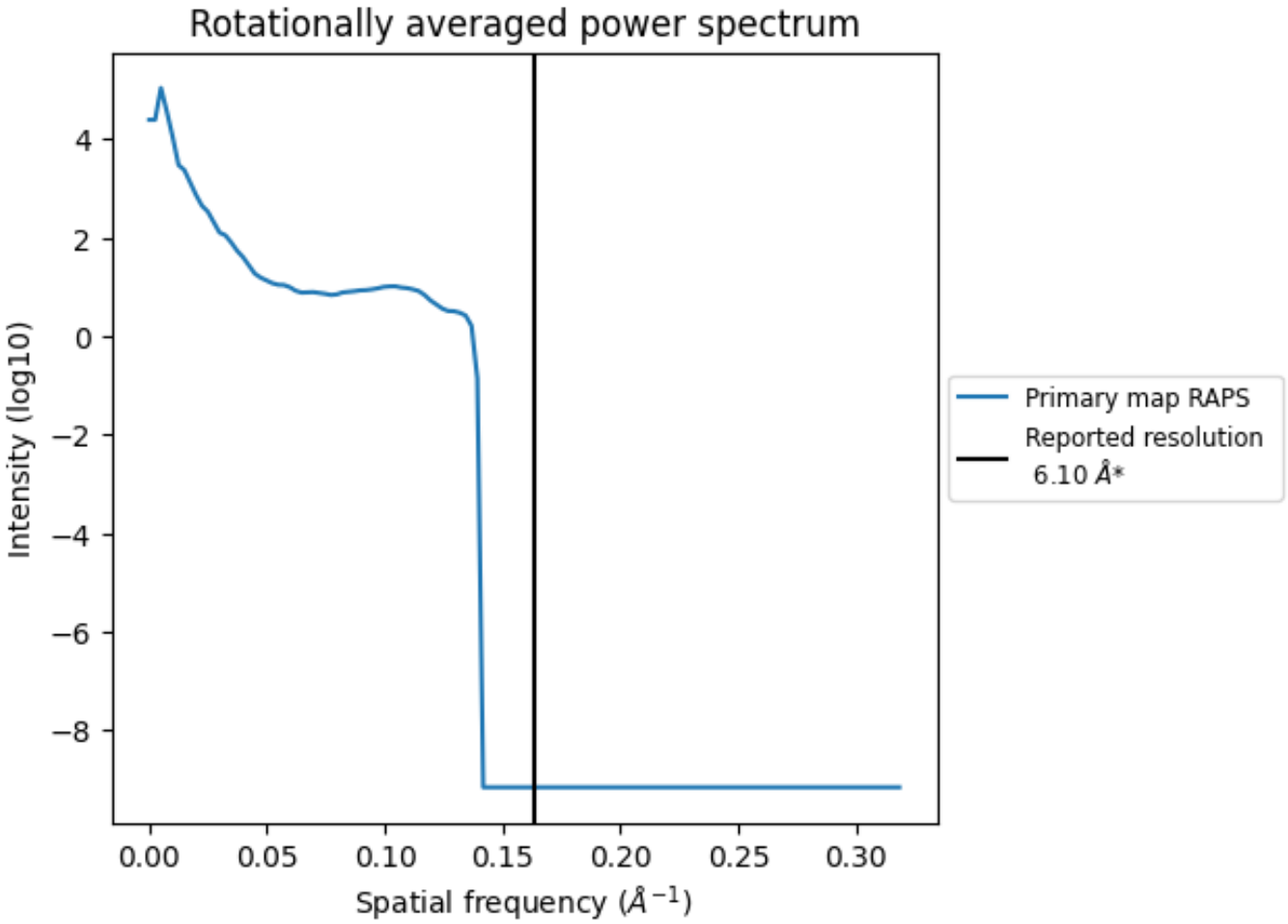
## 7.2 Volume estimate (i)




The volume at the recommended contour level is 746 $nm^3$; this corresponds to an approximate mass of 674 kDa.

The volume estimate graph shows how the enclosed volume varies with the contour level. The recommended contour level is shown as a vertical line and the intersection between the line and the curve gives the volume of the enclosed surface at the given level.

## 7.3 Rotationally averaged power spectrum (i)




*Reported resolution corresponds to spatial frequency of 0.164 Å$^{-1}$

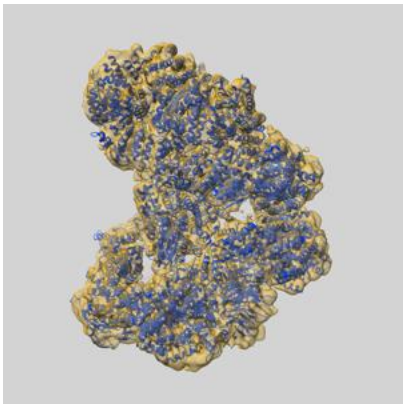
# 8 Fourier-Shell correlation (i)

This section was not generated. No FSC curve or half-maps provided.

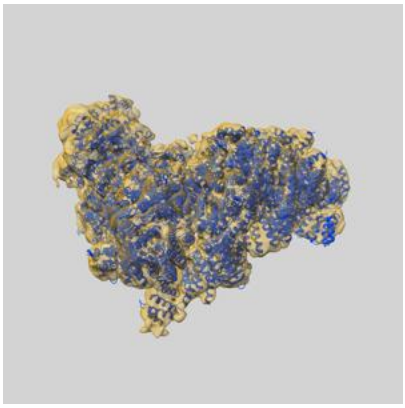
# 9 Map-model fit

This section contains information regarding the fit between EMDB map EMD-4025 and PDB model 5KHR. Per-residue inclusion information can be found in section 3 on page 8.

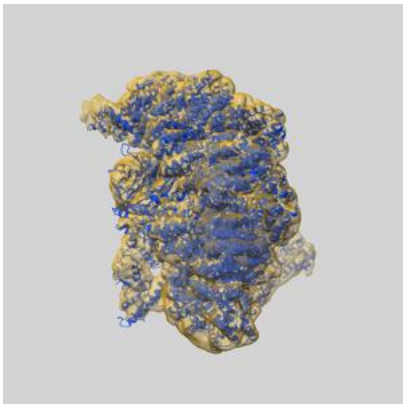
## 9.1 Map-model overlay



X



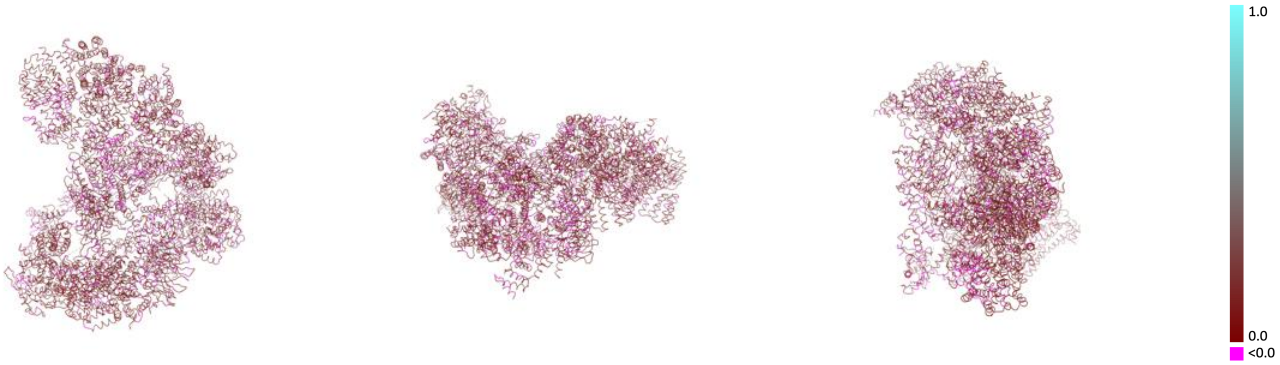
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.081 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

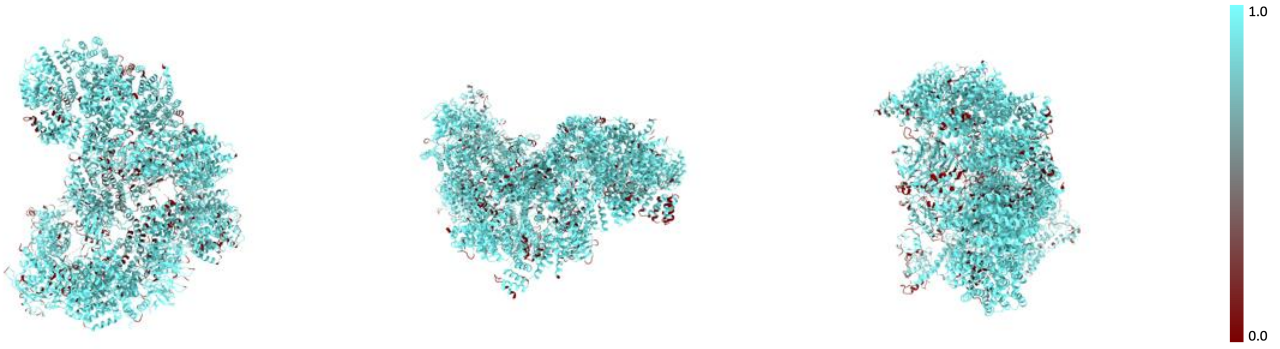
## 9.2 Q-score mapped to coordinate model (i)




X Y Z

The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions at which atoms can be resolved. Low Q-score values may therefore be expected for many entries.

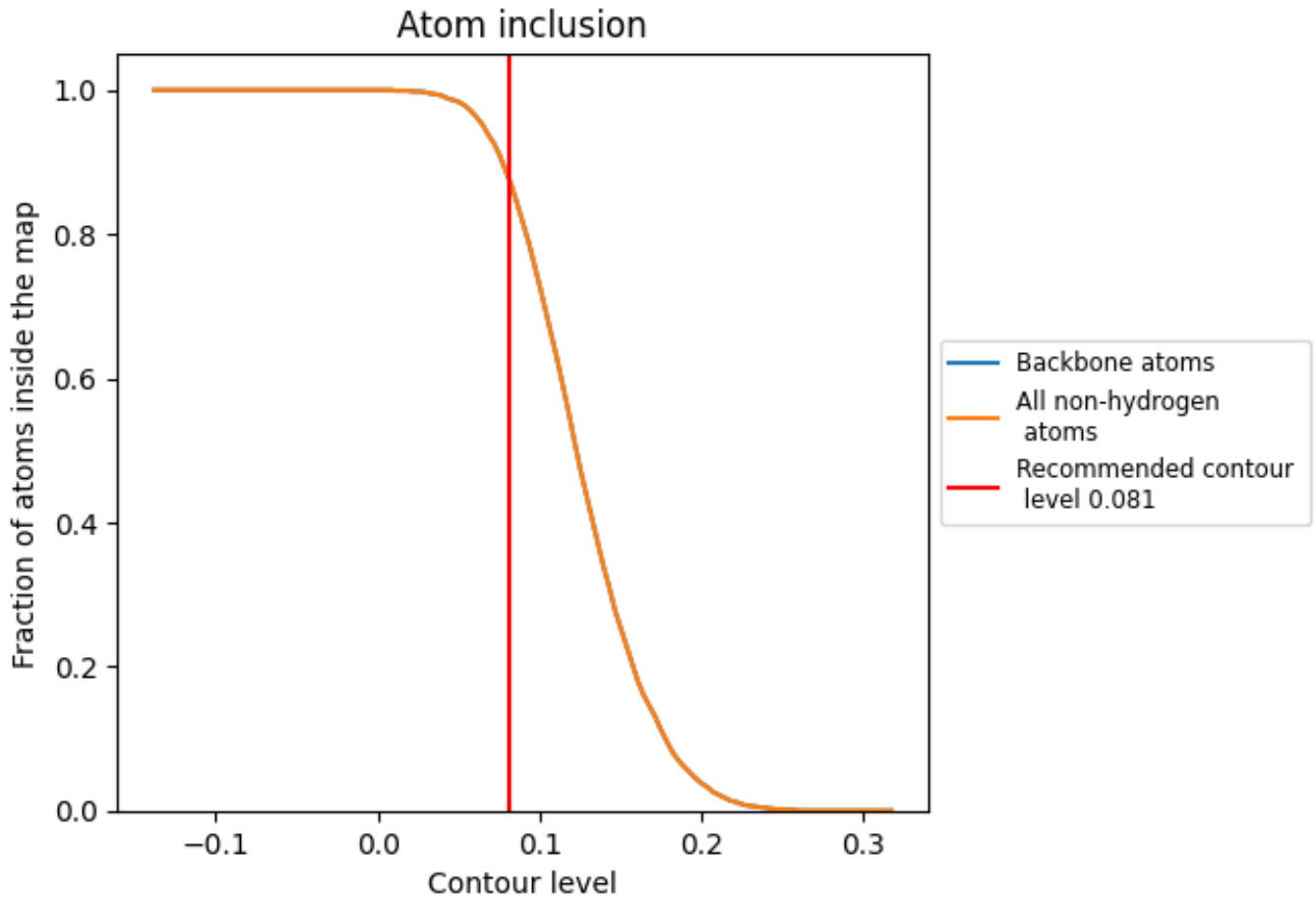
## 9.3 Atom inclusion mapped to coordinate model (i)




X Y Z

The images above show the model with each residue coloured according to its atom inclusion. This shows to what extent they are inside the map at the recommended contour level (0.081).

## 9.4 Atom inclusion (i)




At the recommended contour level, 88% of all backbone atoms, 88% of all non-hydrogen atoms, are inside the map.

## 9.5 Map-model fit summary

The table lists the average atom inclusion at the recommended contour level (0.081) and Q-score for the entire model and for each chain.

| Chain | Atom inclusion | Q-score |
|---|---|---|
| All | 0.8770 | 0.1330 |
| A | 0.8750 | 0.1430 |
| B | 0.7830 | 0.0960 |
| C | 0.8440 | 0.1250 |
| E | 0.9460 | 0.1450 |
| F | 0.9310 | 0.1370 |
| G | 0.6800 | 0.1580 |
| H | 0.9630 | 0.1380 |
| I | 0.9310 | 0.1470 |
| J | 0.9150 | 0.1240 |
| K | 0.9230 | 0.1390 |
| L | 0.8620 | 0.1580 |
| M | 0.7230 | 0.1640 |
| N | 0.7570 | 0.1260 |
| O | 0.8970 | 0.1320 |
| P | 0.9390 | 0.1370 |
| Q | 0.6410 | 0.0790 |
| R | 0.7800 | 0.1190 |
| S | 0.6000 | 0.1080 |
| W | 0.8400 | 0.1380 |
| X | 0.8790 | 0.0910 |
| Y | 0.8870 | 0.1390 |

