



wwPDB/EMDatabank EM Map/Model Validation Summary Report ⓘ

Sep 17, 2017 – 07:21 PM EDT

PDB ID : 5UCY
EMDB ID: : EMD-8539
Title : Cryo-EM map of protofilament of microtubule doublet
Authors : Ichikawa, M.; Liu, D.; Kastritis, P.L.; Basu, K.; Bui, K.H.
Deposited on : unknown
Resolution : 4.60 Å(reported)

This is a wwPDB/EMDatabank EM Map/Model Validation Summary Report
for a publicly released PDB/EMDB entry.

We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
<http://wwpdb.org/validation/2016/EMValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

MolProbity : 4.02b-467
Mogul : 1.7.2 (RC1), CSD as538be (2017)
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20029824

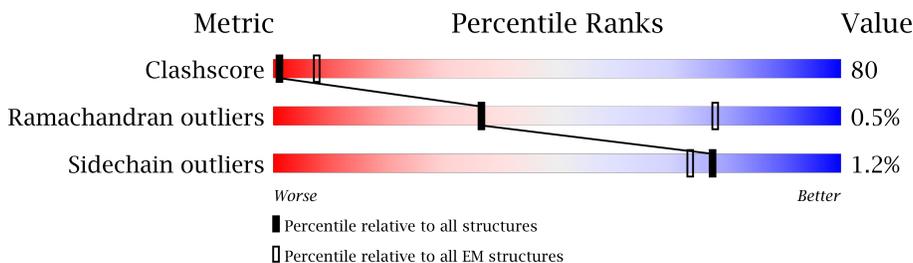
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY

The reported resolution of this entry is 4.60 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 | 125131 | 1336 |
| Ramachandran outliers | 121729 | 1120 |
| Sidechain outliers | 121581 | 1026 |

The table below summarises the geometric issues observed across the polymeric chains. The red, orange, yellow and green segments on the bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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 | A | 441 |  23% 75% . |
| 2 | B | 429 |  21% 77% . |

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 |
|-----|------|-------|-----|-----------|----------|---------|------------------|
| 3 | GTP | A | 501 | - | - | X | - |
| 5 | GDP | B | 501 | - | - | X | - |

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 8338 atoms, of which 1492 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.

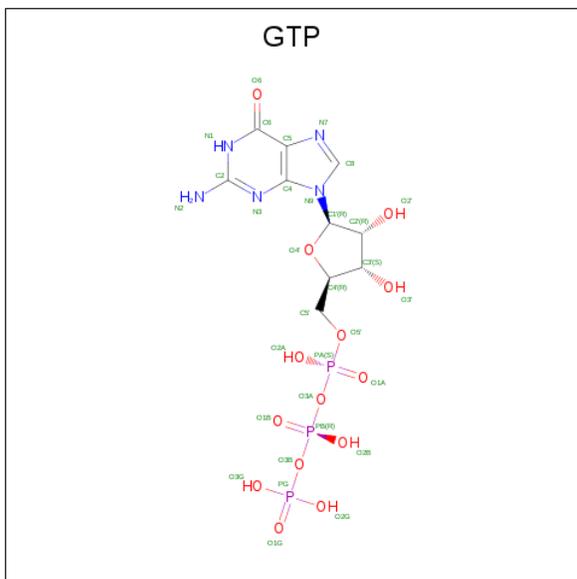
- Molecule 1 is a protein called Tubulin alpha chain.

| Mol | Chain | Residues | Atoms | | | | | AltConf | Trace | |
|-----|-------|----------|-------|------|-----|-----|-----|---------|-------|---|
| | | | Total | C | H | N | O | | | S |
| 1 | A | 441 | 4165 | 2163 | 742 | 581 | 657 | 22 | 0 | 0 |

- Molecule 2 is a protein called Tubulin beta chain.

| Mol | Chain | Residues | Atoms | | | | | AltConf | Trace | |
|-----|-------|----------|-------|------|-----|-----|-----|---------|-------|---|
| | | | Total | C | H | N | O | | | S |
| 2 | B | 429 | 4104 | 2112 | 742 | 576 | 646 | 28 | 0 | 0 |

- Molecule 3 is GUANOSINE-5'-TRIPHOSPHATE (three-letter code: GTP) (formula: $C_{10}H_{16}N_5O_{14}P_3$).

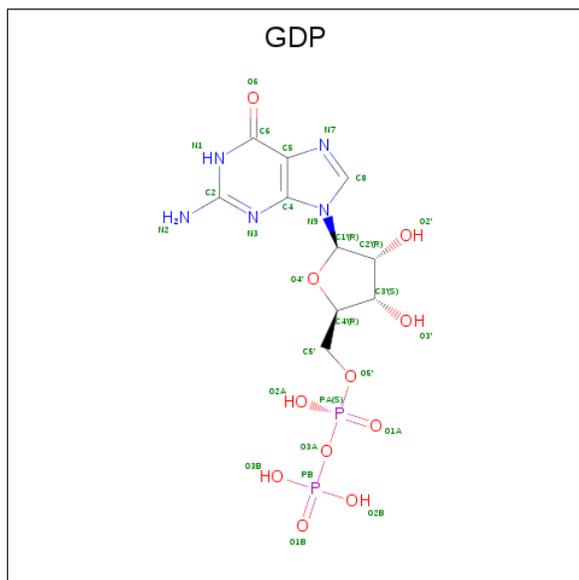


| Mol | Chain | Residues | Atoms | | | | | AltConf | |
|-----|-------|----------|-------|----|---|---|----|---------|---|
| | | | Total | C | H | N | O | | P |
| 3 | A | 1 | 35 | 10 | 3 | 5 | 14 | 3 | 0 |

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

| Mol | Chain | Residues | Atoms | AltConf |
|-----|-------|----------|-----------------|---------|
| 4 | A | 1 | Total Mg 1 1 | 0 |

- Molecule 5 is GUANOSINE-5'-DIPHOSPHATE (three-letter code: GDP) (formula: $C_{10}H_{15}N_5O_{11}P_2$).



| Mol | Chain | Residues | Atoms | | | | | AltConf | |
|-----|-------|----------|-------|----|---|---|----|---------|---|
| | | | Total | C | H | N | O | | P |
| 5 | B | 1 | 33 | 10 | 5 | 5 | 11 | 2 | 0 |

| | |
|------|------|
| F260 | S322 |
| F261 | I323 |
| L262 | K324 |
| L263 | E325 |
| H264 | V326 |
| F265 | D327 |
| F266 | E328 |
| H267 | Q329 |
| G269 | M330 |
| F270 | L331 |
| A271 | N332 |
| P272 | V333 |
| L273 | Q334 |
| T274 | M335 |
| S275 | K336 |
| R276 | M337 |
| G277 | S338 |
| S278 | S339 |
| Q279 | Y340 |
| Q280 | F341 |
| Y281 | V342 |
| R282 | E343 |
| I283 | M344 |
| L284 | I345 |
| T285 | P346 |
| V286 | M347 |
| P287 | M348 |
| E288 | I349 |
| L289 | K350 |
| T290 | S351 |
| S352 | S352 |
| Q291 | I353 |
| Q292 | C354 |
| M293 | D355 |
| F294 | I356 |
| D295 | P357 |
| A296 | P358 |
| I297 | K362 |
| M298 | M363 |
| M299 | A364 |
| M300 | V365 |
| C301 | T366 |
| A302 | F367 |
| A303 | V368 |
| D304 | G369 |
| P305 | M370 |
| R306 | M371 |
| R309 | T372 |
| Y310 | A373 |
| L311 | I374 |
| T312 | Q375 |
| A313 | E376 |
| S314 | M377 |
| A315 | F378 |
| L316 | K379 |
| F317 | R380 |
| R318 | V381 |
| G319 | A382 |
| F385 | L418 |
| L386 | V419 |
| A387 | S420 |
| M388 | E421 |
| F389 | Y422 |
| R390 | Q426 |
| R391 | T429 |
| K392 | |
| A393 | |
| F394 | |
| L395 | |
| Y398 | |
| T399 | |
| G400 | |
| E401 | |
| G402 | |
| M403 | |
| D404 | |
| E405 | |
| M406 | |
| E407 | |
| F408 | |
| T409 | |
| E410 | |
| A411 | |
| E412 | |
| S413 | |
| M414 | |
| M415 | |

4 Experimental information

| Property | Value | Source |
|--------------------------------------|---|-----------|
| Reconstruction method | SINGLE PARTICLE | Depositor |
| Imposed symmetry | POINT, C1 | Depositor |
| Number of particles used | 23 | 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 ($e^-/\text{\AA}^2$) | 45 | Depositor |
| Minimum defocus (nm) | 1200 | Depositor |
| Maximum defocus (nm) | 3800 | Depositor |
| Magnification | 59000 | Depositor |
| Image detector | FEI FALCON II (4k 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: GDP, GTP, MG

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 >2 | RMSZ | # Z >2 |
| 1 | A | 0.58 | 1/3495 (0.0%) | 0.61 | 0/4735 |
| 2 | B | 0.55 | 0/3435 | 0.66 | 3/4648 (0.1%) |
| All | All | 0.57 | 1/6930 (0.0%) | 0.64 | 3/9383 (0.0%) |

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

| Mol | Chain | #Chirality outliers | #Planarity outliers |
|-----|-------|---------------------|---------------------|
| 1 | A | 0 | 1 |
| 2 | B | 0 | 1 |
| All | All | 0 | 2 |

All (1) bond length outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(Å) | Ideal(Å) |
|-----|-------|-----|------|-------|-------|-------------|----------|
| 1 | A | 35 | GLN | C-N | -8.21 | 1.15 | 1.34 |

All (3) bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|-----------|-------|-------------|----------|
| 2 | B | 252 | LYS | CD-CE-NZ | 8.19 | 130.54 | 111.70 |
| 2 | B | 150 | LEU | CA-CB-CG | -5.54 | 102.55 | 115.30 |
| 2 | B | 58 | ARG | NE-CZ-NH1 | 5.20 | 122.90 | 120.30 |

There are no chirality outliers.

All (2) planarity outliers are listed below:

| Mol | Chain | Res | Type | Group |
|-----|-------|-----|------|---------|
| 1 | A | 143 | GLY | Peptide |
| 2 | B | 99 | ASN | Peptide |

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 | 3423 | 742 | 3353 | 545 | 0 |
| 2 | B | 3362 | 742 | 3244 | 558 | 0 |
| 3 | A | 32 | 3 | 9 | 41 | 0 |
| 4 | A | 1 | 0 | 0 | 1 | 0 |
| 5 | B | 28 | 5 | 11 | 20 | 0 |
| All | All | 6846 | 1492 | 6617 | 1078 | 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 80.

The worst 5 of 1078 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) |
|----------------|----------------|--------------------------|-------------------|
| 2:B:12:CYS:HB2 | 5:B:501:GDP:C8 | 1.44 | 1.52 |
| 2:B:12:CYS:SG | 5:B:501:GDP:C6 | 2.05 | 1.49 |
| 2:B:12:CYS:HB2 | 5:B:501:GDP:N7 | 1.19 | 1.46 |
| 2:B:12:CYS:SG | 5:B:501:GDP:C5 | 2.08 | 1.42 |
| 1:A:12:GLY:CA | 3:A:501:GTP:C5 | 2.17 | 1.26 |

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 | A | 439/441 (100%) | 377 (86%) | 59 (13%) | 3 (1%) | 25 | 68 |
| 2 | B | 427/429 (100%) | 388 (91%) | 38 (9%) | 1 (0%) | 51 | 85 |
| All | All | 866/870 (100%) | 765 (88%) | 97 (11%) | 4 (0%) | 37 | 74 |

All (4) Ramachandran outliers are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 1 | A | 49 | PHE |
| 1 | A | 344 | VAL |
| 1 | A | 143 | GLY |
| 2 | B | 142 | GLY |

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 | A | 371/371 (100%) | 365 (98%) | 6 (2%) | 68 | 85 |
| 2 | B | 365/365 (100%) | 362 (99%) | 3 (1%) | 85 | 92 |
| All | All | 736/736 (100%) | 727 (99%) | 9 (1%) | 77 | 88 |

5 of 9 residues with a non-rotameric sidechain are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 1 | A | 283 | HIS |
| 2 | B | 332 | ASN |
| 2 | B | 222 | TYR |
| 1 | A | 224 | TYR |
| 1 | A | 380 | ASN |

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 21 such sidechains are listed below:

| Mol | Chain | Res | Type |
|-----|-------|-----|------|
| 2 | B | 191 | GLN |
| 2 | B | 256 | ASN |
| 2 | B | 396 | HIS |
| 2 | B | 184 | ASN |
| 2 | B | 414 | 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 carbohydrates in this entry.

5.6 Ligand geometry [i](#)

Of 3 ligands modelled in this entry, 1 is monoatomic - leaving 2 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the chemical component dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

| Mol | Type | Chain | Res | Link | Bond lengths | | | Bond angles | | |
|-----|------|-------|-----|------|--------------|------|----------|-------------|------|----------|
| | | | | | Counts | RMSZ | # Z > 2 | Counts | RMSZ | # Z > 2 |
| 3 | GTP | A | 501 | 1 | 27,34,34 | 1.24 | 4 (14%) | 24,54,54 | 1.52 | 2 (8%) |
| 5 | GDP | B | 501 | 2 | 25,30,30 | 1.29 | 4 (16%) | 23,47,47 | 1.58 | 5 (21%) |

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 | GTP | A | 501 | 1 | - | 0/18/38/38 | 0/3/3/3 |
| 5 | GDP | B | 501 | 2 | - | 0/12/32/32 | 0/3/3/3 |

The worst 5 of 8 bond length outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(Å) | Ideal(Å) |
|-----|-------|-----|------|---------|------|-------------|----------|
| 3 | A | 501 | GTP | O4'-C1' | 2.19 | 1.44 | 1.41 |
| 5 | B | 501 | GDP | O4'-C1' | 2.35 | 1.44 | 1.41 |
| 3 | A | 501 | GTP | C6-N1 | 2.53 | 1.40 | 1.36 |
| 3 | A | 501 | GTP | C2-N1 | 2.55 | 1.40 | 1.36 |
| 5 | B | 501 | GDP | C2-N1 | 2.66 | 1.40 | 1.36 |

The worst 5 of 7 bond angle outliers are listed below:

| Mol | Chain | Res | Type | Atoms | Z | Observed(°) | Ideal(°) |
|-----|-------|-----|------|-------------|-------|-------------|----------|
| 5 | B | 501 | GDP | C4-C5-N7 | -2.40 | 107.09 | 109.41 |
| 3 | A | 501 | GTP | C4'-O4'-C1' | -2.30 | 107.32 | 109.77 |
| 5 | B | 501 | GDP | C2'-C3'-C4' | -2.30 | 98.15 | 102.62 |
| 5 | B | 501 | GDP | C4'-O4'-C1' | -2.16 | 107.47 | 109.77 |
| 5 | B | 501 | GDP | C5'-C4'-C3' | -2.10 | 107.28 | 115.29 |

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 61 short contacts:

| Mol | Chain | Res | Type | Clashes | Symm-Clashes |
|-----|-------|-----|------|---------|--------------|
| 3 | A | 501 | GTP | 41 | 0 |
| 5 | B | 501 | GDP | 20 | 0 |

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

The following chains have linkage breaks:

| Mol | Chain | Number of breaks |
|-----|-------|------------------|
| 1 | A | 1 |

All chain breaks are listed below:

| Model | Chain | Residue-1 | Atom-1 | Residue-2 | Atom-2 | Distance (Å) |
|-------|-------|-----------|--------|-----------|--------|--------------|
| 1 | A | 35:GLN | C | 36:MET | N | 1.15 |