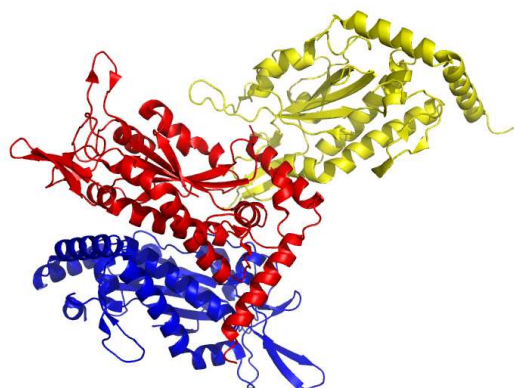


1p4d

Evolutionary trace report by **report_maker**

September 27, 2008



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1 INTRODUCTION

From the original Protein Data Bank entry (PDB id 1p4d):

Title: F factor traI relaxase domain

Compound: Mol id: 1; molecule: traI protein; chain: a, b, c; fragment: 36 kda n-terminal domain of traI (residues 1- 330); synonym: dna helicase i, contains: traI* protein; ec: 3.6.1.-; engineered: yes

Organism, scientific name: Escherichia Coli;

1p4d contains a single unique chain 1p4dC (276 residues long) and its homologues 1p4dA and 1p4dB.

2 CHAIN 1P4DC

1 2.1 P14565 overview

1 From SwissProt, id P14565, 84% identical to 1p4dC:

1 **Description:** TraI protein (DNA helicase I) (EC 3.6.1.-) [Contains: TraI* protein].

1 **Organism, scientific name:** Escherichia coli.

2 **Taxonomy:** Bacteria; Proteobacteria; Gammaproteobacteria; Enterobacteriales; Enterobacteriaceae; Escherichia.

2 **Function:** TraI has been identified as DNA helicase I and it also has an additional activity of site-specific nicking at oriT. DNA helicase I is a potent DNA-dependent ATPase.

Alternative products:

5 Event=Alternative initiation; Comment=2 isoforms, traI (shown here) and traI*, are produced by alternative initiation;

7 **Similarity:** To traI of plasmid IncFII R100.

7 **About:** This Swiss-Prot entry is copyright. It is produced through a collaboration between the Swiss Institute of Bioinformatics and the EMBL outstation - the European Bioinformatics Institute. There are no restrictions on its use as long as its content is in no way modified and this statement is not removed.

2.2 Multiple sequence alignment for 1p4dC

8 For the chain 1p4dC, the alignment 1p4dC.msf (attached) with 14 sequences was used. The alignment was assembled through combination of BLAST searching on the UniProt database and alignment using Muscle program. It can be found in the attachment to this

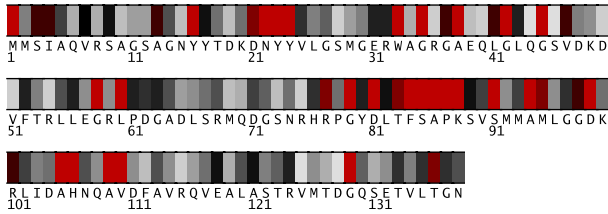


Fig. 1. Residues 1-138 in 1p4dC colored by their relative importance. (See Appendix, Fig.13, for the coloring scheme.)



Fig. 2. Residues 139-307 in 1p4dC colored by their relative importance. (See Appendix, Fig.13, for the coloring scheme.)

report, under the name of 1p4dC.msf. Its statistics, from the *alifold* program are the following:

```

Format:                MSF
Number of sequences:   14
Total number of residues: 3732
Smallest:              255
Largest:               276
Average length:        266.6
Alignment length:      276
Average identity:       42%
Most related pair:     97%
Most unrelated pair:   29%
Most distant seq:      46%

```

Furthermore, 11% of residues show as conserved in this alignment. The alignment consists of 92% prokaryotic sequences. (Descriptions of some sequences were not readily available.) The file containing the sequence descriptions can be found in the attachment, under the name 1p4dC.descr.

2.3 Residue ranking in 1p4dC

The 1p4dC sequence is shown in Figs. 1–2, with each residue colored according to its estimated importance. The full listing of residues in 1p4dC can be found in the file called 1p4dC.ranks_sorted in the attachment.

2.4 Top ranking residues in 1p4dC and their position on the structure

In the following we consider residues ranking among top 25% of residues in the protein. Figure 3 shows residues in 1p4dC colored by their importance: bright red and yellow indicate more conserved/important residues (see Appendix for the coloring scheme). A Pymol script for producing this figure can be found in the attachment.

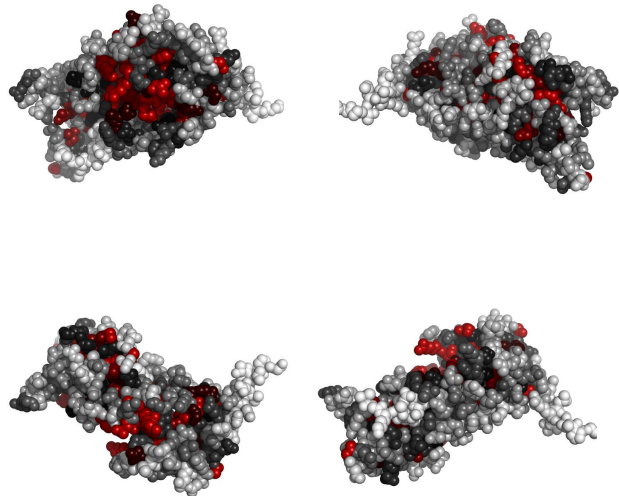


Fig. 3. Residues in 1p4dC, colored by their relative importance. Clockwise: front, back, top and bottom views.

2.4.1 Clustering of residues at 25% coverage. Fig. 4 shows the top 25% of all residues, this time colored according to clusters they belong to. The clusters in Fig.4 are composed of the residues listed

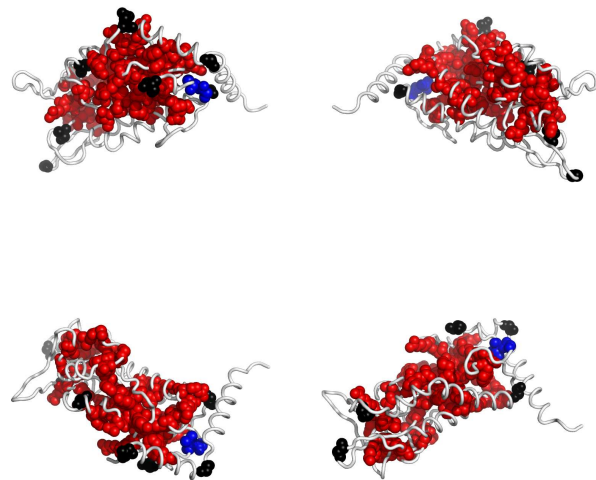


Fig. 4. Residues in 1p4dC, colored according to the cluster they belong to: red, followed by blue and yellow are the largest clusters (see Appendix for the coloring scheme). Clockwise: front, back, top and bottom views. The corresponding Pymol script is attached.

in Table 1.

Table 1.		
cluster color	size	member residues
red	60	1, 3, 4, 7, 16, 21, 22, 23, 24, 33, 35 37, 38, 41, 42, 45, 47, 58, 60, 77 79, 81, 83, 84, 85, 86, 87, 88, 91 94, 95, 98, 99, 101, 105, 106, 109 110, 136, 142, 144, 145, 146, 147 149, 150, 154, 155, 157, 159, 160 164, 166, 172, 173, 175, 200, 224 225, 277
blue	2	228, 229

Table 1. Clusters of top ranking residues in 1p4dC.

2.4.2 *Overlap with known functional surfaces at 25% coverage.*
The name of the ligand is composed of the source PDB identifier and the heteroatom name used in that file.

Interface with 1p4dA. By analogy with 1p4dB – 1p4dA interface. Table 2 lists the top 25% of residues at the interface with 1p4dA. The following table (Table 3) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 2.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
99	D	D(100)	0.12	2/2	4.28
136	T	T(92) S(7)	0.16	1/1	4.90
101	R	R(64) D(28) T(7)	0.22	13/0	4.04
98	G	G(78) E(7) K(14)	0.23	3/3	4.50

Table 2. The top 25% of residues in 1p4dC at the interface with 1p4dA. (Field names: res: residue number in the PDB entry; type: amino acid type; substs: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 3.		
res	type	disruptive mutations
99	D	(R) (FWH) (KYVCAG) (TQM)
136	T	(KR) (FQMWH) (NELPI) (D)
101	R	(TYD) (FVLAWPI) (E) (MCG)
98	G	(FW) (HR) (Y) (KE)

Table 3. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with 1p4dA.

Figure 5 shows residues in 1p4dC colored by their importance, at the interface with 1p4dA.

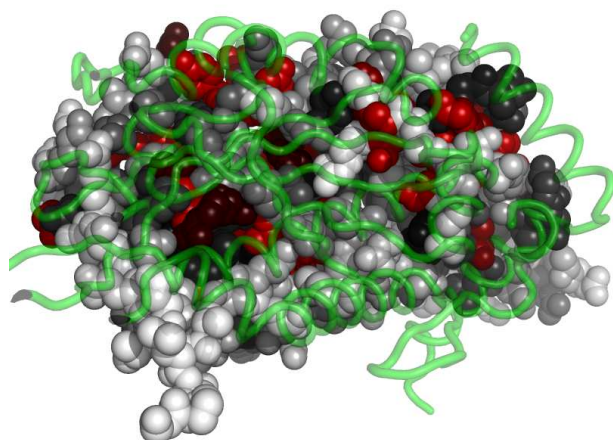


Fig. 5. Residues in 1p4dC, at the interface with 1p4dA, colored by their relative importance. 1p4dA is shown in backbone representation (See Appendix for the coloring scheme for the protein chain 1p4dC.)

1,2-ethanediol binding site. By analogy with 1p4dB – 1p4dEDO610 interface. Table 4 lists the top 25% of residues at the interface with 1p4dEDO610 (1,2-ethanediol). The following table (Table 5) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 4.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
173	K	K(14) R(85)	0.20	7/0	3.70

Table 4. The top 25% of residues in 1p4dC at the interface with 1,2-ethanediol.(Field names: res: residue number in the PDB entry; type: amino acid type; substs: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 5.		
res	type	disruptive mutations
173	K	(Y) (T) (FW) (SVCAG)

Table 5. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with 1,2-ethanediol.

Figure 6 shows residues in 1p4dC colored by their importance, at the interface with 1p4dEDO610.

1,2-ethanediol binding site. Table 6 lists the top 25% of residues at the interface with 1p4dEDO603 (1,2-ethanediol). The following

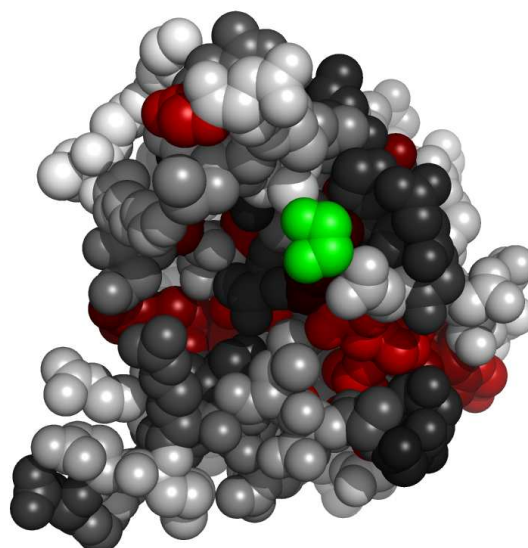


Fig. 6. Residues in 1p4dC, at the interface with 1,2-ethanediol, colored by their relative importance. The ligand (1,2-ethanediol) is colored green. Atoms further than 30Å away from the geometric center of the ligand, as well as on the line of sight to the ligand were removed. (See Appendix for the coloring scheme for the protein chain 1p4dC.)

table (Table 7) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 6.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
105	A	A(100)	0.12	7/5	3.53
101	R	R(64) D(28) T(7)	0.22	7/6	3.63

Table 6. The top 25% of residues in 1p4dC at the interface with 1,2-ethanediol.(Field names: res: residue number in the PDB entry; type: amino acid type; substs: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 7.		
res	type	disruptive mutations
105	A	(KYER) (QHD) (N) (FTMW)
101	R	(TYD) (FVLAWPI) (E) (MCG)

Table 7. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with 1,2-ethanediol.

Figure 7 shows residues in 1p4dC colored by their importance, at the interface with 1p4dEDO603.

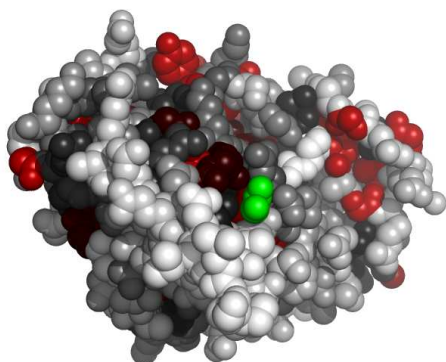


Fig. 7. Residues in 1p4dC, at the interface with 1,2-ethanediol, colored by their relative importance. The ligand (1,2-ethanediol) is colored green. Atoms further than 30Å away from the geometric center of the ligand, as well as on the line of sight to the ligand were removed. (See Appendix for the coloring scheme for the protein chain 1p4dC.)

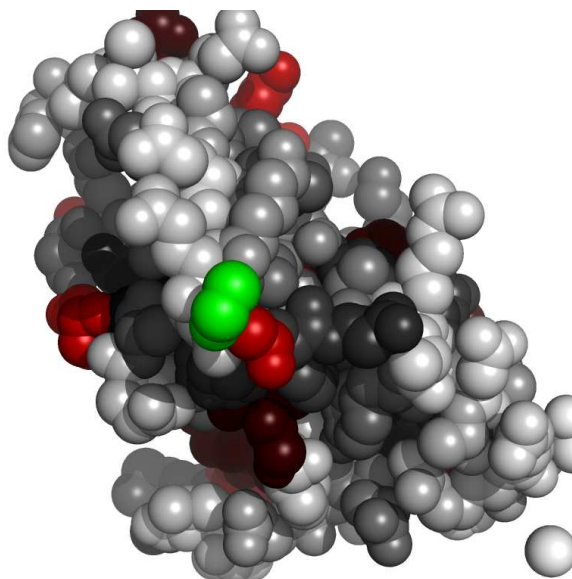


Fig. 8. Residues in 1p4dC, at the interface with 1,2-ethanediol, colored by their relative importance. The ligand (1,2-ethanediol) is colored green. Atoms further than 30Å away from the geometric center of the ligand, as well as on the line of sight to the ligand were removed. (See Appendix for the coloring scheme for the protein chain 1p4dC.)

1,2-ethanediol binding site. By analogy with 1p4dA – 1p4dEDO608 interface. Table 8 lists the top 25% of residues at the interface with 1p4dEDO608 (1,2-ethanediol). The following table (Table 9) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 8.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
285	G	G (92) K (7)	0.14	4/4	4.02

Table 8. The top 25% of residues in 1p4dC at the interface with 1,2-ethanediol.(Field names: res: residue number in the PDB entry; type: amino acid type; substs: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 9.		
res	type	disruptive mutations
285	G	(FEW) (YHDR) (KM) (QLPI)

Table 9. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with 1,2-ethanediol.

Figure 8 shows residues in 1p4dC colored by their importance, at the interface with 1p4dEDO608.

Magnesium ion binding site. Table 10 lists the top 25% of residues at the interface with 1p4dMG902 (magnesium ion). The following table (Table 11) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 10.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
16	Y	Y (100)	0.12	1/0	4.33
146	H	H (100)	0.12	6/0	2.75
157	H	H (100)	0.12	5/0	2.77
159	H	H (100)	0.12	5/0	2.13

Table 10. The top 25% of residues in 1p4dC at the interface with magnesium ion.(Field names: res: residue number in the PDB entry; type: amino acid type; substs: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 11.		
res	type	disruptive mutations
16	Y	(K) (QM) (NEVLAPIR) (D)
146	H	(E) (TQMD) (SNKVCLAPIG) (YR)
157	H	(E) (TQMD) (SNKVCLAPIG) (YR)
159	H	(E) (TQMD) (SNKVCLAPIG) (YR)

continued in next column

Table 11. continued		
res	type	disruptive mutations

Table 11. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with magnesium ion.

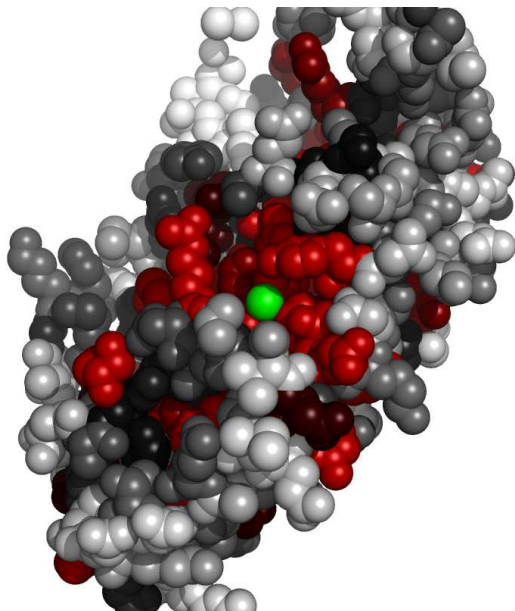


Fig. 9. Residues in 1p4dC, at the interface with magnesium ion, colored by their relative importance. The ligand (magnesium ion) is colored green. Atoms further than 30.Å away from the geometric center of the ligand, as well as on the line of sight to the ligand were removed. (See Appendix for the coloring scheme for the protein chain 1p4dC.)

Figure 9 shows residues in 1p4dC colored by their importance, at the interface with 1p4dMG902.

1,2-ethanediol binding site. By analogy with 1p4dA – 1p4dEDO612 interface. Table 12 lists the top 25% of residues at the interface with 1p4dEDO612 (1,2-ethanediol). The following table (Table 13) suggests possible disruptive replacements for these residues (see Section 3.6).

Table 12.					
res	type	subst's (%)	cvg	noc/ bb	dist (Å)
33	W	W(100)	0.12	1/1	4.45
35	G	G(100)	0.12	4/4	4.09
110	V	V(100)	0.12	1/1	4.97

Table 12. The top 25% of residues in 1p4dC at the interface with 1,2-ethanediol.(Field names: res: residue number in the PDB entry; type: amino acid type; subst's: substitutions seen in the alignment; with the percentage of each type in the bracket; noc/bb: number of contacts with the ligand, with the number of contacts realized through backbone atoms given in the bracket; dist: distance of closest approach to the ligand.)

Table 13.		
res	type	disruptive mutations
33	W	(KE) (TQD) (SNCRG) (M)
35	G	(KER) (FQMWHD) (NYLPI) (SVA)
110	V	(KYER) (QHD) (N) (FTMW)

Table 13. List of disruptive mutations for the top 25% of residues in 1p4dC, that are at the interface with 1,2-ethanediol.

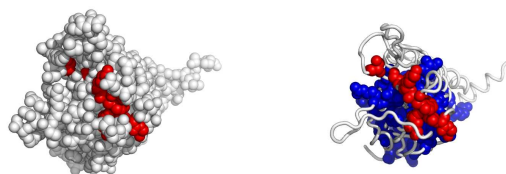


Fig. 11. A possible active surface on the chain 1p4dC. The larger cluster it belongs to is shown in blue.

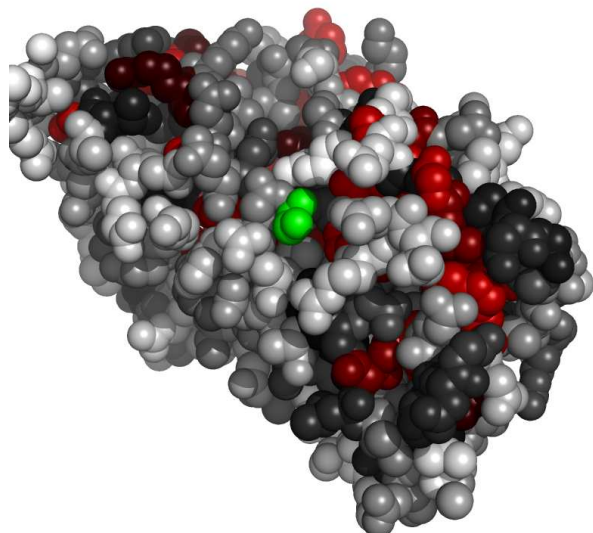


Fig. 10. Residues in 1p4dC, at the interface with 1,2-ethanediol, colored by their relative importance. The ligand (1,2-ethanediol) is colored green. Atoms further than 30Å away from the geometric center of the ligand, as well as on the line of sight to the ligand were removed. (See Appendix for the coloring scheme for the protein chain 1p4dC.)

Figure 10 shows residues in 1p4dC colored by their importance, at the interface with 1p4dEDO612.

2.4.3 Possible novel functional surfaces at 25% coverage. One group of residues is conserved on the 1p4dC surface, away from (or substantially larger than) other functional sites and interfaces recognizable in PDB entry 1p4d. It is shown in Fig. 11. The right panel shows (in blue) the rest of the larger cluster this surface belongs to. The residues belonging to this surface "patch" are listed in Table 14, while Table 15 suggests possible disruptive replacements for these residues (see Section 3.6).

Table 14.			
res	type	substitutions(%)	cvg
42	G	G(100)	0.12
60	L	L(92)I(7)	0.12
172	W	W(78)L(21)	0.12

continued in next column

Table 14. continued			
res	type	substitutions(%)	cvg
175	L	L(92)I(7)	0.16
177	S	S(50)N(50)	0.17
41	L	L(78)A(14)E(7)	0.20
173	K	K(14)R(85)	0.20

Table 14. Residues forming surface "patch" in 1p4dC.

Table 15.		
res	type	disruptive mutations
42	G	(KER) (FQMWHD) (NYLPI) (SVA)
60	L	(YR) (TH) (SKECG) (FQWD)
172	W	(KE) (T) (QDR) (SCG)
175	L	(YR) (TH) (SKECG) (FQWD)
177	S	(R) (FKWH) (YM) (EQ)
41	L	(YR) (H) (T) (K)
173	K	(Y) (T) (FW) (SVCAG)

Table 15. Disruptive mutations for the surface patch in 1p4dC.

Another group of surface residues is shown in Fig. 12. The right panel shows (in blue) the rest of the larger cluster this surface belongs to.

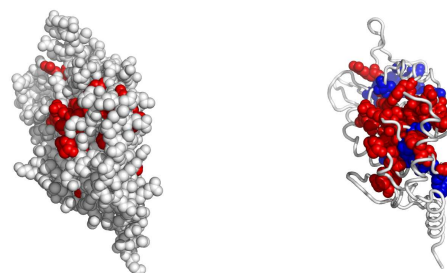


Fig. 12. Another possible active surface on the chain 1p4dC. The larger cluster it belongs to is shown in blue.

The residues belonging to this surface "patch" are listed in Table 16,

while Table 17 suggests possible disruptive replacements for these residues (see Section 3.6).

Table 16.			
res	type	substitutions(%)	cvg
1	M	M(100)	0.12
16	Y	Y(100)	0.12
23	Y	Y(100)	0.12
24	Y	Y(100)	0.12
79	G	G(100)	0.12
81	D	D(100)	0.12
85	S	S(100)	0.12
87	P	P(100)	0.12
88	K	K(100)	0.12
146	H	H(100)	0.12
150	R	R(100)	0.12
157	H	H(100)	0.12
159	H	H(100)	0.12
235	S	S(100)	0.12
277	W	W(100)	0.12
22	N	N(64)D(35)	0.14
86	A	A(85)V(14)	0.14
149	S	S(85)N(14)	0.14
21	D	D(92)E(7)	0.15
224	W	W(28)F(71)	0.15
77	R	R(85)K(14)	0.16
95	M	M(21)L(78)	0.18
83	T	T(92)S(7)	0.19
4	I	I(57)V(42)	0.21
155	Q	Q(78)N(14)D(7)	0.21
3	S	S(64)N(28)D(7)	0.22
98	G	G(78)E(7)K(14)	0.23
145	N	N(28)R(57)Q(14)	0.23
225	E	E(85)D(14)	0.25

Table 16. Residues forming surface "patch" in 1p4dC.

Table 17.		
res	type	disruptive mutations
1	M	(Y)(TH)(SCRG)(FWD)
16	Y	(K)(QM)(NEVLAPIR)(D)
23	Y	(K)(QM)(NEVLAPIR)(D)
24	Y	(K)(QM)(NEVLAPIR)(D)
79	G	(KER)(FQMWHD)(NYLPI)(SVA)
81	D	(R)(FWH)(KYVCAG)(TQM)
85	S	(KR)(FQMW)(NYELPI)(D)
87	P	(YR)(TH)(SKECG)(FQWD)
88	K	(Y)(FTW)(SVCAG)(HD)
146	H	(E)(TQMD)(SNKVCLAPIG)(YR)
150	R	(TD)(SYEVCLAPIG)(FMW)(N)
157	H	(E)(TQMD)(SNKVCLAPIG)(YR)
159	H	(E)(TQMD)(SNKVCLAPIG)(YR)
235	S	(KR)(FQMW)(NYELPI)(D)

continued in next column

Table 17. continued		
res	type	disruptive mutations
277	W	(KE)(TQD)(SNCRG)(M)
22	N	(Y)(FWH)(TR)(VCAG)
86	A	(KYER)(QHD)(N)(FTMW)
149	S	(R)(FKWH)(YM)(EQ)
21	D	(R)(FWH)(YVCAG)(K)
224	W	(KE)(TQD)(SNCRG)(M)
77	R	(T)(YD)(SVCAG)(FELWPI)
95	M	(Y)(TH)(R)(SCG)
83	T	(KR)(FQMW)(NELPI)(D)
4	I	(YR)(H)(TKE)(SQCDG)
155	Q	(Y)(FWH)(T)(VCAG)
3	S	(R)(FKWH)(YM)(Q)
98	G	(FW)(HR)(Y)(KE)
145	N	(Y)(T)(FW)(H)
225	E	(FWH)(R)(YVCAG)(T)

Table 17. Disruptive mutations for the surface patch in 1p4dC.

3 NOTES ON USING TRACE RESULTS

3.1 Coverage

Trace results are commonly expressed in terms of coverage: the residue is important if its "coverage" is small - that is if it belongs to some small top percentage of residues [100% is all of the residues in a chain], according to trace. The ET results are presented in the form of a table, usually limited to top 25% percent of residues (or to some nearby percentage), sorted by the strength of the presumed evolutionary pressure. (I.e., the smaller the coverage, the stronger the pressure on the residue.) Starting from the top of that list, mutating a couple of residues should affect the protein somehow, with the exact effects to be determined experimentally.

3.2 Known substitutions

One of the table columns is "substitutions" - other amino acid types seen at the same position in the alignment. These amino acid types may be interchangeable at that position in the protein, so if one wants to affect the protein by a point mutation, they should be avoided. For example if the substitutions are "RVK" and the original protein has an R at that position, it is advisable to try anything, but RVK. Conversely, when looking for substitutions which will *not* affect the protein, one may try replacing, R with K, or (perhaps more surprisingly), with V. The percentage of times the substitution appears in the alignment is given in the immediately following bracket. No percentage is given in the cases when it is smaller than 1%. This is meant to be a rough guide - due to rounding errors these percentages often do not add up to 100%.

3.3 Surface

To detect candidates for novel functional interfaces, first we look for residues that are solvent accessible (according to DSSP program) by at least 10\AA^2 , which is roughly the area needed for one water molecule to come in the contact with the residue. Furthermore, we require that these residues form a "cluster" of residues which have neighbor within 5\AA from any of their heavy atoms.

Note, however, that, if our picture of protein evolution is correct, the neighboring residues which *are not* surface accessible might be equally important in maintaining the interaction specificity - they should not be automatically dropped from consideration when choosing the set for mutagenesis. (Especially if they form a cluster with the surface residues.)

3.4 Number of contacts

Another column worth noting is denoted “noc/bb”; it tells the number of contacts heavy atoms of the residue in question make across the interface, as well as how many of them are realized through the backbone atoms (if all or most contacts are through the backbone, mutation presumably won’t have strong impact). Two heavy atoms are considered to be “in contact” if their centers are closer than 5Å.

3.5 Annotation

If the residue annotation is available (either from the pdb file or from other sources), another column, with the header “annotation” appears. Annotations carried over from PDB are the following: site (indicating existence of related site record in PDB), S-S (disulfide bond forming residue), hb (hydrogen bond forming residue, jb (james bond forming residue), and sb (for salt bridge forming residue).

3.6 Mutation suggestions

Mutation suggestions are completely heuristic and based on complementarity with the substitutions found in the alignment. Note that they are meant to be **disruptive** to the interaction of the protein with its ligand. The attempt is made to complement the following properties: small [AVGSTC], medium [LPNQDEMILK], large [WFYHR], hydrophobic [LPVAMWFI], polar [GTCY]; positively [KHR], or negatively [DE] charged, aromatic [WFYH], long aliphatic chain [EKRRQM], OH-group possession [SDETY], and NH2 group possession [NQRK]. The suggestions are listed according to how different they appear to be from the original amino acid, and they are grouped in round brackets if they appear equally disruptive. From left to right, each bracketed group of amino acid types resembles more strongly the original (i.e. is, presumably, less disruptive) These suggestions are tentative - they might prove disruptive to the fold rather than to the interaction. Many researcher will choose, however, the straightforward alanine mutations, especially in the beginning stages of their investigation.

4 APPENDIX

4.1 File formats

Files with extension “ranks_sorted” are the actual trace results. The fields in the table in this file:

- alignment# number of the position in the alignment
- residue# residue number in the PDB file
- type amino acid type
- rank rank of the position according to older version of ET
- variability has two subfields:
 1. number of different amino acids appearing in in this column of the alignment
 2. their type

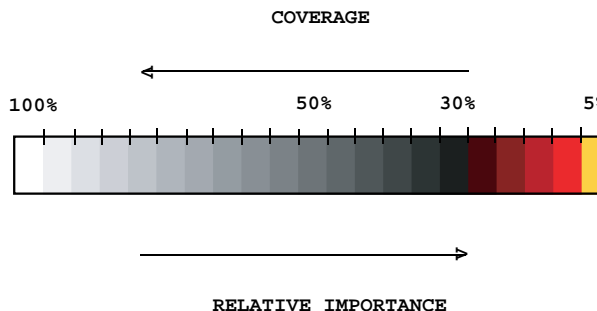


Fig. 13. Coloring scheme used to color residues by their relative importance.

- rho ET score - the smaller this value, the lesser variability of this position across the branches of the tree (and, presumably, the greater the importance for the protein)
- cvg coverage - percentage of the residues on the structure which have this rho or smaller
- gaps percentage of gaps in this column

4.2 Color schemes used

The following color scheme is used in figures with residues colored by cluster size: black is a single-residue cluster; clusters composed of more than one residue colored according to this hierarchy (ordered by descending size): red, blue, yellow, green, purple, azure, turquoise, brown, coral, magenta, LightSalmon, SkyBlue, violet, gold, bisque, LightSlateBlue, orchid, RosyBrown, MediumAquamarine, DarkOliveGreen, CornflowerBlue, grey55, burlywood, LimeGreen, tan, DarkOrange, DeepPink, maroon, BlanchedAlmond.

The colors used to distinguish the residues by the estimated evolutionary pressure they experience can be seen in Fig. 13.

4.3 Credits

4.3.1 **Alistat** *alistat* reads a multiple sequence alignment from the file and shows a number of simple statistics about it. These statistics include the format, the number of sequences, the total number of residues, the average and range of the sequence lengths, and the alignment length (e.g. including gap characters). Also shown are some percent identities. A percent pairwise alignment identity is defined as (idents / MIN(len1, len2)) where idents is the number of exact identities and len1, len2 are the unaligned lengths of the two sequences. The “average percent identity”, “most related pair”, and “most unrelated pair” of the alignment are the average, maximum, and minimum of all (N)(N-1)/2 pairs, respectively. The “most distant seq” is calculated by finding the maximum pairwise identity (best relative) for all N sequences, then finding the minimum of these N numbers (hence, the most outlying sequence). *alistat* is copyrighted by HHMI/Washington University School of Medicine, 1992-2001, and freely distributed under the GNU General Public License.

4.3.2 **CE** To map ligand binding sites from different source structures, *report_maker* uses the CE program:

<http://cl.sdsc.edu/>. Shindyalov IN, Bourne PE (1998) "Protein structure alignment by incremental combinatorial extension (CE) of the optimal path". *Protein Engineering* 11(9) 739-747.

4.3.3 DSSP In this work a residue is considered solvent accessible if the DSSP program finds it exposed to water by at least 10\AA^2 , which is roughly the area needed for one water molecule to come in the contact with the residue. DSSP is copyrighted by W. Kabsch, C. Sander and MPI-MF, 1983, 1985, 1988, 1994 1995, CMBI version by Elmar.Krieger@cmbi.kun.nl November 18,2002,

<http://www.cmbi.kun.nl/gv/dssp/descrip.html>.

4.3.4 HSSP Whenever available, report_maker uses HSSP alignment as a starting point for the analysis (sequences shorter than 75% of the query are taken out, however); R. Schneider, A. de Daruvar, and C. Sander. "The HSSP database of protein structure-sequence alignments." *Nucleic Acids Res.*, 25:226-230, 1997.

<http://swift.cmbi.kun.nl/swift/hssp/>

4.3.5 LaTeX The text for this report was processed using L^AT_EX; Leslie Lamport, "LaTeX: A Document Preparation System Addison-Wesley," Reading, Mass. (1986).

4.3.6 Muscle When making alignments "from scratch", report maker uses Muscle alignment program: Edgar, Robert C. (2004), "MUSCLE: multiple sequence alignment with high accuracy and high throughput." *Nucleic Acids Research* 32(5), 1792-97.

<http://www.drive5.com/muscle/>

4.3.7 Pymol The figures in this report were produced using Pymol. The scripts can be found in the attachment. Pymol is an open-source application copyrighted by DeLano Scientific LLC (2005). For more information about Pymol see <http://pymol.sourceforge.net/>. (Note for Windows users: the attached package needs to be unzipped for Pymol to read the scripts and launch the viewer.)

4.4 Note about ET Viewer

Dan Morgan from the Lichtarge lab has developed a visualization tool specifically for viewing trace results. If you are interested, please visit:

<http://mammoth.bcm.tmc.edu/traceview/>

The viewer is self-unpacking and self-installing. Input files to be used with ETV (extension .etvx) can be found in the attachment to the main report.

4.5 Citing this work

The method used to rank residues and make predictions in this report can be found in Mihalek, I., I. Reš, O. Lichtarge. (2004). "A Family of Evolution-Entropy Hybrid Methods for Ranking of Protein Residues by Importance" *J. Mol. Bio.* **336**: 1265-82. For the original version of ET see O. Lichtarge, H.Bourne and F. Cohen (1996). "An Evolutionary Trace Method Defines Binding Surfaces Common to Protein Families" *J. Mol. Bio.* **257**: 342-358.

report_maker itself is described in Mihalek I., I. Res and O. Lichtarge (2006). "Evolutionary Trace Report Maker: a new type of service for comparative analysis of proteins." *Bioinformatics* **22**:1656-7.

4.6 About report_maker

report_maker was written in 2006 by Ivana Mihalek. The 1D ranking visualization program was written by Ivica Reš. report_maker is copyrighted by Lichtarge Lab, Baylor College of Medicine, Houston.

4.7 Attachments

The following files should accompany this report:

- 1p4dC.complex.pdb - coordinates of 1p4dC with all of its interacting partners
- 1p4dC.etvx - ET viewer input file for 1p4dC
- 1p4dC.cluster_report.summary - Cluster report summary for 1p4dC
- 1p4dC.ranks - Ranks file in sequence order for 1p4dC
- 1p4dC.clusters - Cluster descriptions for 1p4dC
- 1p4dC.msf - the multiple sequence alignment used for the chain 1p4dC
- 1p4dC.descr - description of sequences used in 1p4dC msf
- 1p4dC.ranks_sorted - full listing of residues and their ranking for 1p4dC
- 1p4dC.1p4dA.if.pml - Pymol script for Figure 5
- 1p4dC.cbcbvg - used by other 1p4dC – related pymol scripts
- 1p4dC.1p4dEDO610.if.pml - Pymol script for Figure 6
- 1p4dC.1p4dEDO603.if.pml - Pymol script for Figure 7
- 1p4dC.1p4dEDO608.if.pml - Pymol script for Figure 8
- 1p4dC.1p4dMG902.if.pml - Pymol script for Figure 9
- 1p4dC.1p4dEDO612.if.pml - Pymol script for Figure 10