

# **Mechanistic Insights into Ferredoxin-NADP(H)-Reductase Catalysis Involving the Conserved Glutamate in the Active Site**

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## **Supporting Information**

Table 1: Partial Charges of the flavin isoalloxazine ring.

Atom	FAD	FADH <sup>•</sup>	FADH <sub>2</sub>	FAD <sup>•-</sup>
N1	-0.744883	-0.792492	-0.752827	-0.778810
HN1	0.000000	0.000000	0.459134	0.000000
C2	0.979264	0.996910	0.967921	0.980265
O2	-0.701395	-0.738142	-0.719930	-0.807856
N3	-0.729075	-0.741433	-0.729028	-0.761840
H3	0.413039	0.408825	0.413084	0.402695
C4	0.723433	0.748511	0.744274	0.724561
O4	-0.635995	-0.678005	-0.683674	-0.743137
C4X	0.214096	-0.182070	-0.234883	0.077900
N5	-0.601790	-0.272552	-0.419799	-0.775444
HN5	0.000000	0.352647	0.332867	0.000000
C5X	0.495945	0.210617	0.239268	0.542325
C6	-0.352594	-0.332772	-0.398402	-0.395594
H6	0.176242	0.187306	0.187098	0.141026
C7	0.127757	0.114925	0.110814	0.097311
C8	0.069069	0.073721	0.022091	0.000077
C9	-0.249185	-0.290764	-0.310631	-0.271688
H9	0.194324	0.191728	0.192713	0.180241
C9A	-0.046423	0.108567	0.090894	-0.105126
N10	-0.011589	-0.155388	-0.221859	0.017271
C10	0.351818	0.513896	0.467344	0.288310
C7M	-0.149784	-0.172592	-0.142909	-0.099306
H7M1	0.059883	0.066580	0.051825	0.035933
H7M2	0.065753	0.064723	0.048772	0.046150
H7M3	0.059979	0.066603	0.052026	0.036059
C8M	-0.136753	-0.166658	-0.128109	-0.108192
H8M1	0.071014	0.068870	0.047390	0.048917
H8M2	0.071414	0.069429	0.048386	0.048696
H8M3	0.051215	0.058372	0.042280	0.035073
C1'	0.230208	0.215778	0.214766	0.144412
H11'	0.002521	0.002430	0.004553	-0.000113
H12'	0.002521	0.002430	0.004553	-0.000113

Table 2: Partial Charges of the iron-sulfur cluster.

Atom	ox	red
FE1	0.820000	0.963000
FE2	0.797000	0.952000
S1	-0.637000	-0.864000
S2	-0.590000	-0.852000
1CB	-0.048000	-0.036000
1HB1	0.041000	0.017000
1HB2	0.013000	-0.059000
1SG	-0.593000	-0.752000
2CB	-0.003000	0.016000
2HB1	0.037000	0.019000
2HB2	0.007000	-0.085000
2SG	-0.661000	-0.801000
3CB	-0.052000	-0.149000
3HB1	0.034000	0.059000
3HB2	0.041000	0.023000
3SG	-0.636000	-0.725000
4CB	0.058000	-0.038000
4HB1	0.040000	0.094000
4HB2	-0.039000	-0.057000
4SG	-0.629000	-0.725000

Table 3: Protonation  $\Delta G_{\text{TR},7}$  and energy contributions,  $\Delta\Delta G^{\text{Born}}$ ,  $\Delta\Delta G^{\text{back}}$ ,  $\Delta G_{\text{TR},7}^{\text{inter}}$  of Glu312 in different steps of the reaction cycle, calculated at pH 7.0 (kcal/mol). In case of the flavin the three forms are FAD (ox), FADH $\cdot$  (se) and FADH $_2$  (red), in case of NADP(H) the two forms are NADP $^+$  (ox) and NADPH (red). Structures were modeled based on PDB entry 1gaw for the intermediates without Fd bound and based on PDB entry 1gaq for intermediates with Fd. The major difference in the FNR structure between the two PDB entries is a different rotamer of Glu312. Therefore, the calculations without Fd were also done with PDB entry 1gaq with Fd deleted (intermediates marked by \*).

		FNR complex					Intermediate		
		Flavin	NADP(H)	Fd	$\Delta G_{\text{TR},7}$	$\Delta\Delta G^{\text{Born}}$	$\Delta\Delta G^{\text{back}}$	$\Delta G_{\text{TR},7}^{\text{inter}}$	Figure 4
FNR without Fd bound		ox			2.8	-2.2	0.7	0.6	I
		se			3.1	-2.2	1.0	0.6	
		red			2.5	-2.2	0.4	0.6	
		ox	ox		4.9	-2.2	2.8	0.7	II
		se	ox		5.3	-2.2	3.2	0.7	V
		red	ox		4.7	-2.2	2.5	0.7	VIIIb
		ox	red		2.8	-2.2	0.7	0.7	IX
		se	red		3.2	-2.2	1.1	0.7	
		red	red		2.6	-2.2	0.5	0.7	
FNR with Fd bound		ox			-1.4	-7.0	1.1	0.8	I*
		se			-0.6	-7.0	1.9	0.8	
		red			-1.6	-7.0	0.9	0.8	
		ox	ox		3.3	-7.2	6.0	0.8	II*
		se	ox		4.1	-7.2	6.8	0.8	V*
		red	ox		3.1	-7.2	5.8	0.9	VIIIb*
		ox	red		-0.3	-7.2	2.3	0.9	IX*
		se	red		0.5	-7.2	3.2	0.9	
		red	red		-0.5	-7.2	2.2	0.9	
		ox	ox	ox	-0.3	-11.2	5.9	1.3	
		se	ox	ox	1.0	-11.2	7.1	1.4	IV
		red	ox	ox	-1.0	-11.2	5.2	1.3	VII
		ox	red	ox	-5.9	-11.2	0.2	1.4	VIIIa
		se	red	ox	-4.8	-11.2	1.3	1.4	
		red	red	ox	-6.6	-11.2	-0.5	1.4	
		ox	ox	red	-2.5	-11.2	3.6	1.4	III
		se	ox	red	-1.3	-11.2	4.7	1.4	VI
		red	ox	red	-3.2	-11.2	2.9	1.4	
		ox	red	red	-8.1	-11.2	-2.1	1.6	
		se	red	red	-6.9	-11.2	-1.0	1.6	
		red	red	red	-8.7	-11.2	-2.8	1.6	
		ox		ox	-6.6	-11.1	-0.5	1.3	
		se		ox	-5.4	-11.1	0.7	1.3	
	red		ox	-7.2	-11.1	-1.1	1.3		
	ox		red	-8.7	-11.1	-2.7	1.4		
	se		red	-7.5	-11.1	-1.6	1.4		
	red		red	-9.3	-11.1	-3.3	1.5		

## Alignment of Bacterial FNRs

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Oceanicaulis_alexandrii      .....
Maricaulis_maris            .....
Mesorhizobium_loti          .....
Mesorhizobium_sp.           .....
Aurantimonas_sp.           .....
Fulvimarina_pelagi          .....
Bartonella_quintana         .....
Bartonella_henselae         .....
Bartonella_tribocorum       .....
Bartonella_bacilliformis    .....
Hoeflea_phototrophica       .....
Sinorhizobium_meliloti      .....
Sinorhizobium_medicae       .....
Agrobacterium_tumefaciens    .....
Rhizobium_leguminosarum     MEWNAFNSSPICNICLASDSSSSDETGSATA
Rhizobium_etli              .....
Stappia_aggregata           .....
Hyphomonas_neptunium        .....
Rhodobacter_sphaeroides     .....
Paracoccus_denitrificans    .....
Rhodobacter_capsulatus      .....
Jannaschia_sp.              .....M
Loktanella_vestfoldensis    .....MGHDEH
Dinoroseobacter_shibae      .....MNKP
Phaeobacter_gallaeciensis   .....MDP
Silicibacter_sp.            .....M
Sagittula_stellata          .....MDT
Oceanicola_batsensis        .....MARD
Roseovarius_sp.             .....MN
Roseobacter_denitrificans    .....
Roseobacter_litoralis       .....
Roseovarius_nubinhibens     .....
Silicibacter_pomeroyi      .....
Sulfitobacter_sp.          .....
Oceanibulbus_indolifex      .....
Rhodobacterales_bacterium   .....
Oceanicola_granulosus       .....
Burkholderia_dolosa         .....
Burkholderia_multivorans    .....
Burkholderia_cenocepacia    .....
Burkholderia_ambifaria      .....
Burkholderia_vietnamiensis  .....
Burkholderia_ubonensis      .....
Burkholderia_thailandensis   .....
Burkholderia_pseudomallei   .....
Burkholderia_oklahomensis   .....
Hahella_chejuensis         .....
Reinekea_sp.                .....
Pseudomonas_putida          .....
Pseudomonas_entomophila     .....
Pseudomonas_fluorescens     .....
Pseudomonas_mendocina       .....
Ralstonia_eutropha          .....MHIPEIPRWRCRLRLRRPQACVK
Cupriavidus_taiwanensis     .....
Methylobacterium_radiotolerans .....
Methylobacterium_extorquens .....
Methylobacterium_nodulans   .....
Xanthobacter_autotrophicus  .....
Brucella_melitensis         .....
Brucella_ovis               .....
Brucella_suis               .....
Ochrobactrum_anthropi       .....
Psychrobacter_arcticus      .....
Psychrobacter_cryohalolentis .....
Psychrobacter_sp.           .....
Caulobacter_crescentus      .....
consensus                   .....

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Oceanicaulis\_alexandrii MAM.....GAFTEEIV  
 Maricaulis\_maris MTMTATAP...AKKNAVSAKPGPFTVETV  
 Mesorhizobium\_lotii MNTTSAFN..TAGARPLQFPIPANVYAETV  
 Mesorhizobium\_sp. MSTAAALQN..VEAADKLEFPIPAGVYAERV  
 Aurantimonas\_sp. MSSLAQQ...PEHSPEPAFPIPAGVFAETV  
 Fulvimarina\_pelagi MSSVAEK...TAET..ESFPIPANVFAETV  
 Bartonella\_quintana MNTPATHVQSNINSVSSSFPIPENVFALTV  
 Bartonella\_henselae MNTSASNVQSNISSVASDFPIPENVFALTV  
 Bartonella\_tribocorum MNTSATNVPSNISSVA..DFPIPANVFALTV  
 Bartonella\_bacilliformis MSTSIPNVKADISSTASNFPPIPENVFTLTV  
 Hoeflea\_phototrophica MNQIVR.....PTSNAGSYEIPAGVFAETV  
 Sinorhizobium\_meliloti MNAPAK.....KEDFAVQAPAGVFAETV  
 Sinorhizobium\_medicae MNAPAK.....KEDFAVQAPAGVFAETV  
 Agrobacterium\_tumefaciens MNAPAK.....TEDFAIKIPDGVYAETV  
 Rhizobium\_leguminosarum MNAPAK.....TEDFASSIPAGVYAETV  
 Rhizobium\_etli MNAPAK.....TEDFASSIPAGVYAETV  
 Stappia\_aggregata MNVLAK.....PADLEAAAPAGAFVEEV  
 Hyphomonas\_neptunium MKVN.....PNGPTEETV  
 Rhodobacter\_sphaeroides .....MNO.....NAAIVKTLPDAQTV  
 Paracoccus\_denitrificans MTLDSLVDI.....AAKPAKTLPDAQTV  
 Rhodobacter\_capsulatus ..TTVNETT.....PIAPAKVLPDAQTV  
 Jannaschia\_sp. MTEQTPVTQTD...AAPVKATPTLPDAQTV  
 Loktanella\_vestfoldensis MTEQSPVNH.....ASAKIVPQLPDMQTV  
 Dinoroseobacter\_shibae TDVMSTVTD.....ATPIKVPTLPDAQTV  
 Phaeobacter\_gallaeciensis MNEMTPVTEAATDPK.PAKAVPALPDAQTV  
 Silicibacter\_sp. MNEITPVSEPVTEAAAPAKAKPALPDAQTV  
 Sagittula\_stellata MTEMTPVTDATAAATAPAKK..AVPDAQTV  
 Oceanicola\_batsensis DMTEATVTE.....QAIPKVPTLPDAQTV  
 Roseovarius\_sp. EMTAVTQAT.....AKAPKTLAIPDAQIV  
 Roseobacter\_denitrificans MTEHAPVNK.....EAATKVPTLPDAQTV  
 Roseobacter\_litoralis MTEQATVNK.....ETATKVPTLPDAQTV  
 Roseovarius\_nubinihibens MNEIADVTD.....ASPIKAKPALPDAQIV  
 Silicibacter\_pomeroyi MTEMRPVTE.....AAAIKAPTLPDSQTV  
 Sulfitobacter\_sp. MTEQNVVTQ.....TDAKPVPPTLPDAQTV  
 Oceanibulbus\_indolifex MTEQTKVNQ.....TAAKPVPPTLPDAQSV  
 Rhodobacterales\_bacterium MTEQNPVNT.....ENAKPVKALPDAQIV  
 Oceanicola\_granulosus MTEQSTVTQ.....ADARPVKALPDAQIV  
 Burkholderia\_dolosa .....MSK..FDTATV  
 Burkholderia\_multivorans .....MSK..YDTAIV  
 Burkholderia\_cenocepacia .....MSK..YDTATV  
 Burkholderia\_ambifaria .....MSK..YDTATV  
 Burkholderia\_vietnamiensis .....MSK..YDTATV  
 Burkholderia\_ubonensis .....MSK..YDTATV  
 Burkholderia\_thailandensis .....MSK..FDTATV  
 Burkholderia\_pseudomallei .....MSK..FDTATV  
 Burkholderia\_oklahomensis .....MSK..FDTATV  
 Hahella\_chejuensis .....MSG..MRKETV  
 Reinekea\_sp. ....MANT..LRKETV  
 Pseudomonas\_putida .....MSN..MNHERV  
 Pseudomonas\_entomophila .....MSN..MNHERV  
 Pseudomonas\_fluorescens .....MSN..MNHERV  
 Pseudomonas\_mendocina .....MPRNRVFRFPILFEEVIMSN..MNVERV  
 Ralstonia\_eutropha ILPAVFGAASCRCIPR.FAMSN..LNQOSI  
 Cupriavidus\_taiwanensis .....MRCIPR.LAMSN..LNQOSI  
 Methylobacterium\_radiotolerans .....MSK..FHEARV  
 Methylobacterium\_extorquens .....MSK..YNEERV  
 Methylobacterium\_nodulans .....MSN..FNEERV  
 Xanthobacter\_autotrophicus MWPPSPFRARSGACRDRILKMSN..FNEETV  
 Brucella\_melitensis .....MSSN..FNQETV  
 Brucella\_ovis .....MSSN..FNQETV  
 Brucella\_suis .....MSSN..FNQETV  
 Ochrobactrum\_anthropi .....MSSN..FNQETV  
 Psychrobacter\_arcticus .....MSK..LRTETV  
 Psychrobacter\_cryohalolentis .....MSK..LRTETV  
 Psychrobacter\_sp. ....MSK..FHTETV  
 Caulobacter\_crescentus .....MKEAPYFVEKV  
 consensus

	20	30	40
Oceanicaulis_alexandrii	I AVR	HYTDR LF SFRVTR	P Q SFRFRS GEFV M
Maricaulis_maris	LSVT	HYTDR LF HFRITR	P D AFRFRS GEFIM
Mesorhizobium_loti	VSVK	HYTDR LF SFRITR	P Q S LFRFRS GEFV M
Mesorhizobium_sp.	VAVK	HYTDR LF SFRITR	P Q TFRFRS GEFV M
Aurantimonas_sp.	TKVT	HYTDS LF AFRITR	P Q SFRFRS GEFV M
Fulvimarina_pelagi	TSVT	HYTDR LF AFRMTR	P Q SFRFRS GEFV M
Bartonella_quintana	QEVY	HYTDH LF KFRLNR	P E SFRFRS GEFV M
Bartonella_henselae	QEVY	HYTDR LF KFRLNR	P E SFRFRS GEFV M
Bartonella_tribocorum	QEVY	HYTDR LF KFRLNR	P E SFRFRS GEFV M
Bartonella_bacilliformis	QEVY	HYTDR LF KFRLNR	P N NFRFRS GEFIM
Hoeflea_phototrophica	TSVQ	HYTDR LF KIRITR	P A SFRFRS GEFV M
Sinorhizobium_meliloti	TSVE	HYTDR LF RFRMTR	P Q EFRFRS GEFAM
Sinorhizobium_medicae	TSVE	HYTDR LF RFRMTR	P K EFRFRS GEFAM
Agrobacterium_tumefaciens	LSVE	HYTDH LF RFRMTR	P A GFRFRS GEFAM
Rhizobium_leguminosarum	LSVT	HYTDR LF RFTMTR	P Q GFRFRS GEFAM
Rhizobium_etli	LAVT	HYTDR LF RFTMTR	P Q GFRFRS GEFAM
Stappia_aggregata	KFVQ	HYTDR LF RFRMTR	P A SFRFRS GEFV M
Hyphomonas_neptunium	LSVE	HYTDR LF RFRMTR	P Q SFRFRS GEFV M
Rhodobacter_sphaeroides	TSVO	HWTDR LF SFRVTR	P Q S LFRFRS GEFV M
Paracoccus_denitrificans	TSVR	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Rhodobacter_capsulatus	TSVR	HWTDR LF SFRVTR	P Q T LFRFRS GEFV M
Jannaschia_sp.	TEVK	HYTDR LF SFRCTR	P A S LFRFRS GEFV M
Loktanella_vestfoldensis	TEVK	HYTDR LF SFRVTR	P A S LFRFRS GEFV M
Dinoroseobacter_shibae	LSVK	HWTDR LF SFRVTR	P Q T LFRFRS GEFV M
Phaeobacter_gallaeciensis	TEVK	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Silicibacter_sp.	TQVK	HWTDR LF SFRCTR	P A S LFRFRS GEFV M
Sagittula_stellata	TEVR	HWTDR LF SFRCTR	P A S LFRFRS GEFV M
Oceanicola_batsensis	THVK	HWTDR LF SFRCTR	P A S LFRFRS GEFV M
Roseovarius_sp.	TQVT	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Roseobacter_denitrificans	TAVO	HYTDR LF SFRVTR	P A S LFRFRS GEFV M
Roseobacter_litoralis	TAVO	HYTDR LF SFRVTR	P A S LFRFRS GEFV M
Roseovarius_nubinihibens	TEVT	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Silicibacter_pomeroyi	TQVK	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Sulfitobacter_sp.	TSVK	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Oceanibulbus_indolifex	TSVT	HWTDR LF SFRVTR	P A S LFRFRS GEFV M
Rhodobacterales_bacterium	TSVT	HWTDR LF SFRVTR	P K S LFRFRS GEFV M
Oceanicola_granulosus	TEVR	HYTDR LF SFRVTR	P A S LFRFRS GEFV M
Burkholderia_dolosa	QSVH	HWTDR LF SFTCTR	R E P S LFRFRS GEFV M
Burkholderia_multivorans	QSVH	HWTDR LF SFTCTR	R E P S LFRFRS GEFV M
Burkholderia_cenocepacia	QSVH	HWTDR LF SFTCTR	R E A S LFRFRS GEFV M
Burkholderia_ambifaria	QSVH	HWTDR LF SFTCTR	R E P S LFRFRS GEFV M
Burkholderia_vietnamiensis	QSVH	HWTDR LF SFTCTR	R E P S LFRFRS GEFV M
Burkholderia_ubonensis	QSVH	HWTDR LF SFTCTR	R E P S LFRFRS GEFV M
Burkholderia_thailandensis	LSVH	HWTDR LF SFTCTR	R D Q G LFRFRS GEFV M
Burkholderia_pseudomallei	LSVH	HWTDR LF SFTCTR	R D Q A LFRFRS GEFV M
Burkholderia_oklahomensis	LSVH	HWTDR LF SFTCTR	R D Q A LFRFRS GEFV M
Hahella_chejuensis	TSVR	HWNDT LF SFTTSR	P D P SFRFRS GEFV M
Reinekea_sp.	TEVH	HWNES LF SFKTTR	R D M GFRFRS GEFV M
Pseudomonas_putida	LSVH	HWNDT LF SFKCTR	R D P G LFRFRS GEFV M
Pseudomonas_entomophila	LSVH	HWNDT LF SFKCTR	R D P G LFRFRS GEFV M
Pseudomonas_fluorescens	LSVH	HWNDT LF SFKCTR	R D P G LFRFRS GEFV M
Pseudomonas_mendocina	LSVH	HWNDT LF SFKCTR	R D P G LFRFRS GEFV M
Ralstonia_eutropha	LSVH	HWTDR LF SFTCTR	R D P GFRFRS GEFV M
Cupriavidus_taiwanensis	LSVH	HWTDR LF SFTCTR	R D P GFRFRS GEFV M
Methylobacterium_radiotolerans	LSVH	HWTDR LF SFRITR	R D P AFRFRS GEFV M
Methylobacterium_extorquens	LSVH	HWTDR LF SFRITR	R D P SFRFRS GEFV M
Methylobacterium_nodulans	LSVH	HWTDR LF SFRITR	R D P SFRFRS GEFV M
Xanthobacter_autotrophicus	TSVH	HWTDR LF SFTCTR	R D P G LFRFRS GEFV M
Brucella_melitensis	TDIH	HWNDT LF SFRITR	R D P GFRFRS GEFV M
Brucella_ovis	TDIH	HWNDT LF SFRITR	R D P GFRFRS GEFV M
Brucella_suis	TDIH	HWNDT LF SFRITR	R D P GFRFRS GEFV M
Ochrobactrum_anthropi	TDIH	HWNDT LF SFRITR	R D P GFRFRS GEFV M
Psychrobacter_arcticus	TEVH	HWNDT LF SIKTTR	R D D G LFRFRS GEFV M
Psychrobacter_cryohalolentis	TEVH	HWNDT LF SIKTTR	R D D G LFRFRS GEFV M
Psychrobacter_sp.	TYVH	HWNDT LF TIKTTR	R D A G LFRFRS GEFV M
Caulobacter_crescentus	LWVK	HWTDR LF SFAITR	P A SFRFRS GEFV M
consensus		* ** * ** * * *	

	50	60
Oceanicaulis_alexandrii	I G L . M V D G . . . . . K P L L R A Y S	I A S P S W D E
Maricaulis_maris	I G L P K E D G . . . . . K P L L R A Y S	L A S P F W D E
Mesorhizobium_loti	I G L P N A E . . . . . K P V F R A Y S	V A S P A W D E
Mesorhizobium_sp.	I G L P N A E . . . . . K P V F R A Y S	I A S P A W D E
Aurantimonas_sp.	I G L P N A A . . . . . K P V Y R A Y S	I A S P A W D E
Fulvimarina_pelagi	I G L P N A E . . . . . K P V Y R A Y S	I A S P A W D E
Bartonella_quintana	I G L P N A E . . . . . K P I Y R A Y S	I A S P F W D E
Bartonella_henselae	I G L P N A E . . . . . K P I Y R A Y S	I A S P F W D E
Bartonella_tribocorum	I G L P N A E . . . . . K P I Y R A Y S	I A S P F W D E
Bartonella_bacilliformis	I G L P N A E . . . . . K P V Y R A Y S	I A S P F W D E
Hoeflea_phototrophica	I G L P N A E . . . . . K P V F R A Y S	I A S P S W D E
Sinorhizobium_meliloti	I G L M V G D . . . . . K P V Y R A Y S	I A S P A W D E
Sinorhizobium_medicae	I G L M V G D . . . . . K P I Y R A Y S	I A S P A W D E
Agrobacterium_tumefaciens	I G L M V G E . . . . . K P I Y R A Y S	I A S P A W D E
Rhizobium_leguminosarum	I G L M V E G . . . . . K P V F R A Y S	I A S P A W A E
Rhizobium_etli	I G L M V E G . . . . . K P V F R A Y S	I A S P A W A E
Stappia_aggregata	I G L M I D S . . . . . K P L Y R A Y S	I A S P A W D E
Hyphomonas_neptunium	I G L P K E D G . . . . . K P L L R A Y S	I A S P A W D E
Rhodobacter_sphaeroides	I G L L D E . . . . . R G K P I M R A Y S	I A S P N W D E
Paracoccus_denitrificans	I G L P D D . . . . . N G K P I L R A Y S	I A S P N W D E
Rhodobacter_capsulatus	I G L L D D . . . . . N G K P I M R A Y S	I A S P A W D E
Jannaschia_sp.	I G L M G E P H P E T G K Q K P L L R A Y S	I A S P S W D E
Loktanella_vestfoldensis	I G L M G D E D P E T G K R K P I M R A Y S	I A S P S W D E
Dinoroseobacter_shibae	I G L M G D P D P K T G K Q K P L L R A Y S	I A S P S W D E
Phaeobacter_gallaeciensis	I G L M N D P D P K T G K V K P L L R A Y S	I A S P S W D E
Silicibacter_sp.	I G L M G D P D P K T G K Q K P L L R A Y S	I A S P S W D E
Sagittula_stellata	I G L M Q T . D P K S G K E K P L L R A Y S	I A S P S W D E
Oceanicola_batsensis	I G L M G . . . . D T G . . R P L L R A Y S	I A S P S W D E
Roseovarius_sp.	I G L M Q T . D E K T G K E K P L L R A Y S	I A S P S W D D
Roseobacter_denitrificans	I G L M G D P D P K T G K Q K P L L R A Y S	I A S P S W D D
Roseobacter_litoralis	I G L M G D P D P K T G K Q K P L M R A Y S	I A S P S W D D
Roseovarius_nubinihibens	I G L M G D P H P E T G K Q K P L L R A Y S	I A S P S W D E
Silicibacter_pomeroyi	I G L L G D . . . . . N G K P L L R A Y S	I A S P A W D E
Sulfitobacter_sp.	I G L M G D P H P E T G K Q K P L L R A Y S	I A S P S W D E
Oceanibulbus_indolifex	I G L M G D P H P E T G K Q K P L L R A Y S	I A S P A W D D
Rhodobacterales_bacterium	I G L L K D . . . . . D G R P L L R A Y S	I A S P S W D E
Oceanicola_granulosus	I G L M G D . . . . . N G K P L L R A Y S	I A S P S W D D
Burkholderia_dolosa	V G L . . . . . E V D . G K P L T R A Y S	I V S P N Y E E
Burkholderia_multivorans	V G L . . . . . E V D . G K P L A R A Y S	I V S P N Y E E
Burkholderia_menocepacia	V G L . . . . . E V D . G K P L A R A Y S	I V S P N Y E E
Burkholderia_ambifaria	V G L . . . . . E V D . G K P L A R A Y S	I V S P N Y E E
Burkholderia_vietnamiensis	V G L . . . . . E V D . G K P L A R A Y S	I V S P N Y E D
Burkholderia_ubonensis	V G L . . . . . E V D . G K P L A R A Y S	I V S P N Y E E
Burkholderia_thailandensis	V G L . . . . . E V D . G K P L T R A Y S	I V S P N Y E E
Burkholderia_pseudomallei	V G L . . . . . E V D . G K P L T R A Y S	I V S P N Y E E
Burkholderia_oklahomensis	V G L . . . . . E V D . G K P L T R A Y S	I V S P N Y E E
Hahella_chejuensis	I G L . . . . . E Q D S G R P L M R A Y S	I A S A N Y E E
Reinekea_sp.	I G L . . . . . E K D D G R P L M R A Y S	I A S A N Y E E
Pseudomonas_putida	I G L . . . . . Q Q D N G R P L M R A Y S	I A S P N W E E
Pseudomonas_entomophila	I G L . . . . . Q Q D S G R P L M R A Y S	I A S P N W E E
Pseudomonas_fluorescens	I G L . . . . . Q Q P N G R P L M R A Y S	I A S P N W E E
Pseudomonas_mendocina	I G L . . . . . Q Q D N G R P L M R A Y S	I A S P N W E E
Ralstonia_eutropha	V G L . . . . . E V N . G R P L L R A Y S	I A S A N Y E E
Cupriavidus_taiwanensis	V G L . . . . . E V N . G R P L L R A Y S	I A S A N Y E E
Methylobacterium_radiotolerans	I G L . . . . . E V E . G R P L L R A Y S	V V S A N Y E D
Methylobacterium_extorquens	I G I . . . . . E V E . G R P L L R A Y S	V V S A N Y E E
Methylobacterium_nodulans	I G L . . . . . K S D . G K P L L R A Y S	V V S A N Y E D
Xanthobacter_autotrophicus	I G L . . . . . K V D . G K P L L R A Y S	M A S A N Y E P
Brucella_melitensis	M G L . . . . . E V N . G K P L T R A Y S	I A S S L Y E D
Brucella_ovis	M G L . . . . . E V N . G K P L T R A Y S	I A S S L Y E D
Brucella_suis	M G L . . . . . E V N . G K P L T R A Y S	I A S S L Y E D
Ochrobactrum_anthropi	M G L . . . . . E V N . G K P L T R A Y S	I A S S L Y E D
Psychrobacter_arcticus	I G L . . . . . V V D . G K P L L R A Y S	I A S P N Y E E
Psychrobacter_cryohalolentis	I G L . . . . . V V D . G K P L L R A Y S	I A S P N Y E E
Psychrobacter_sp.	I G I . . . . . M V D . G K P L M R A Y S	I A S P N Y E E
Caulobacter_crescentus	I G L P P R E . . E L G E K K P I L R A Y S	I G S P S F A E
consensus	*	* * * * *



	70	80	90								
Oceanicaulis_alexandrii	ELD	FY	SIKV	PD	GP	LT	SQ	LO	HIEP	GD	TILMG
Maricaulis_maris	ALD	FY	SIKV	PD	GP	LT	SR	LO	HIKQ	GD	EVLLG
Mesorhizobium_lotii	ELE	FF	SIKV	PD	GP	LT	SE	LO	KIQV	GD	TVIMR
Mesorhizobium_sp.	ELE	FF	SIKV	PD	GP	LT	QH	LO	KITP	GD	IVLMR
Aurantimonas_sp.	ELE	FF	SIKV	AN	GP	LT	EH	LO	KIQV	GD	TVLMR
Fulvimarina_pelagi	EIE	FF	SIKV	PG	GP	LT	EH	LO	KIQE	GD	TVLMR
Bartonella_quintana	QLE	FF	SIKV	PG	GS	LT	EH	LO	KIKI	GD	TVLMR
Bartonella_henselae	QLE	FF	SIKV	PG	GP	LT	EH	LO	KIKI	GD	TVLMR
Bartonella_tribocorum	QLE	FF	SIKV	PG	GP	LT	EH	LO	KIKI	GD	TVLMR
Bartonella_bacilliformis	QLE	FF	SIKV	PG	GP	LT	EH	LO	KIKI	GD	TVLMR
Hoeflea_phototrophica	EIE	FY	SIKV	PG	GP	LT	EH	LO	KIVP	GD	TLLMR
Sinorhizobium_meliloti	ELE	FF	SIKV	PD	GP	LT	SH	LO	GIKP	GD	QVLMR
Sinorhizobium_medicae	ELE	FF	SIKV	PD	GP	LT	SH	LO	GIKP	GD	QVLMR
Agrobacterium_tumefaciens	ELE	FF	SIKV	PD	GP	LT	SR	LO	AIKP	GD	TVLMR
Rhizobium_leguminosarum	ELE	FF	SIKV	PD	GP	LT	SH	LO	AIKP	GD	QVLMR
Rhizobium_etli	ELE	FF	SIKV	PD	GP	LT	SH	LO	AIKP	GD	QVLMR
Stappia_aggregata	ELE	FF	SIKV	PD	GP	LT	SH	LO	KIQP	GD	AVLMK
Hyphomonas_neptunium	ELE	FY	SIKV	PD	GP	LT	SR	LO	KIQP	GD	KVLLG
Rhodobacter_sphaeroides	ELE	FY	SIKV	PD	GP	LT	SR	LO	HIQP	GD	QIILR
Paracoccus_denitrificans	ELE	FY	SIKV	PD	GP	LT	SR	LO	NIQP	GD	QIILR
Rhodobacter_capsulatus	ELE	FY	SIKV	PD	GP	LT	SR	LO	HIKV	GE	QIILR
Jannaschia_sp.	ELE	FY	SIKV	PD	GP	LT	SR	LO	HIQP	GE	QIILR
Loktanella_vestfoldensis	ELE	FY	SIKV	QD	GP	LT	SK	LO	HIQP	GD	GLILR
Dinoroseobacter_shibae	ELE	FY	SIKV	PD	GP	LT	SR	LO	HIQP	GE	QIILR
Phaeobacter_gallaeciensis	EME	FY	SIKV	QD	GP	LT	SR	LO	HIKV	GE	EIILR
Silicibacter_sp.	EME	FY	SIKV	QD	GP	LT	SK	LO	HIKV	GE	EIILR
Sagittula_stellata	ELE	FY	SIKV	QD	GP	LT	SR	LO	HIQP	GD	EIVLR
Oceanicola_batsensis	ELE	FY	SIKV	QD	GP	LT	SR	LO	HLAV	GE	EIILR
Roseovarius_sp.	ELE	FY	SIKV	QD	GP	LT	SR	LO	HIEV	GE	EIILR
Roseobacter_denitrificans	ELE	FY	SIKV	PD	GP	LT	SR	LO	HIQP	GD	EIILR
Roseobacter_litoralis	ELE	FY	SIKV	QD	GP	LT	SR	LO	HIQP	GD	EIILR
Roseovarius_nubinihibens	ELE	FY	SIKV	QD	GP	LT	SK	LO	HIQP	GD	EIILR
Silicibacter_pomeroyi	ELE	FY	SIKV	QD	GP	LT	SK	LO	HIQP	GD	EIILR
Sulfitobacter_sp.	ELE	FY	SIKV	QD	GP	LT	SK	LO	HIQP	GD	QIILR
Oceanibulbus_indolifex	ELE	FY	SIKV	QD	GP	LT	SK	LO	HIQP	GD	QIILR
Rhodobacterales_bacterium	ELE	FY	SIKV	QD	GP	LT	SR	LO	HLKV	GD	EILIR
Oceanicola_granulosus	ELE	FY	SIKV	PD	GP	LT	SK	LO	HIQP	GD	QIILR
Burkholderia_dolosa	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	KVLIG
Burkholderia_multivorans	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	TVLIG
Burkholderia_cenocepacia	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	TVLIG
Burkholderia_ambifaria	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	SVLIG
Burkholderia_vietnamiensis	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	TVLIG
Burkholderia_ubonensis	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	TVLIG
Burkholderia_thailandensis	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKI	GD	PVLIG
Burkholderia_pseudomallei	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	PVLIG
Burkholderia_oklahomensis	HLE	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	AVLIG
Hahella_chejuensis	ELE	FF	SIKV	PD	GP	LT	SR	LO	KISV	GD	EIIMS
Reinekea_sp.	ELE	FF	SIKV	PD	GP	LT	SR	LO	KIQV	GD	EIVVG
Pseudomonas_putida	HLE	FF	SIKV	PD	GP	LT	SQ	LO	HLKE	GD	EIIIS
Pseudomonas_entomophila	HLE	FF	SIKV	PD	GP	LT	SQ	LO	HLKE	GD	EIIIS
Pseudomonas_fluorescens	HLE	FF	SIKV	PD	GP	LT	SQ	LO	HLKE	GD	EIIIS
Pseudomonas_mendocina	HLE	FF	SIKV	PD	GP	LT	SQ	LO	HLKE	GD	EIIIS
Ralstonia_eutropha	TLE	FF	SIKV	PD	GP	LT	SR	LO	HLRE	GD	QIFVG
Cupriavidus_taiwanensis	TLE	FF	SIKV	PD	GP	LT	SR	LO	HLRE	GD	QIYVG
Methylobacterium_radiotolerans	ELE	FF	SIKV	PD	GP	LT	SK	LO	HLKV	GD	PIIVG
Methylobacterium_extorquens	ELE	FF	SIKV	PN	GP	LT	SK	LO	HLKV	GD	PIIMG
Methylobacterium_nodulans	ELE	FF	SIKV	PN	GP	LT	SK	LO	HLKV	GD	PIIVS
Xanthobacter_autotrophicus	DLQ	FF	SIKV	QD	GP	LT	SR	LO	HLKV	GD	KLLVG
Brucella_melitensis	GLE	FF	SIKV	PN	GP	LT	SK	LO	HLKK	GD	QIIVS
Brucella_ovis	GLE	FF	SIKV	PN	GP	LT	SK	LO	HLKK	GD	QIIVS
Brucella_suis	GLE	FF	SIKV	PN	GP	LT	SK	LO	HLKK	GD	QIIVS
Ochrobactrum_anthropi	GLE	FF	SIKV	PN	GP	LT	SK	LO	HLKV	GD	QIILS
Psychrobacter_arcticus	HLE	FF	SIKV	QD	GP	LT	SR	LO	HIKV	GD	ELLVS
Psychrobacter_cryohalolentis	HLE	FF	SIKV	QD	GP	LT	SR	LO	HIKV	GD	ELLVS
Psychrobacter_sp.	HLE	FF	SIKV	QD	GP	LT	SR	LO	HIKV	GD	ELIIS
Caulobacter_crescentus	ELE	FF	SIKV	PD	GP	LT	SR	LO	LIQE	GD	EILLG
consensus	*		****	*	**	*	*	*	*	*	*

	100	110	120			
Oceanicaulis_alexandrii	KKSV	GTLVLDAL	EPGKRLYLLS	TGTGIAPF		
Maricaulis_maris	RKPT	GTLVLDAL	KPGKRLYMIS	TGTGIAPF		
Mesorhizobium_loti	QKST	GTLVVDAL	TPAKRLFMIS	TGTGIAPF		
Mesorhizobium_sp.	QKST	GTLVNDAL	TPAKRLYMIS	TGTGIAPF		
Aurantimonas_sp.	KKPT	GTLVHDAL	KPGKRLFLFS	TGTGIAPF		
Fulvimarina_pelagi	KKPT	GTLVHDAL	IPGKRLFLFS	TGTGIAPF		
Bartonella_quintana	KKST	GTLVLDAL	IPGKRLYLLS	TGTGVAPF		
Bartonella_henselae	KKST	GTLVLDAL	IPGKRLYLLS	TGTGVAPF		
Bartonella_tribocorum	KKST	GTLVLDAL	IPGKRLYLLS	TGTGVAPF		
Bartonella_bacilliformis	KKST	GTLVLDAL	IPGKRLYLLS	TGTGVAPF		
Hoeflea_phototrophica	KKPT	GTLVLDAL	VPGKRLYMFS	TGTGIAPF		
Sinorhizobium_meliloti	KKPT	GTLVLDAL	VPGRRLYMFS	TGTGIAPF		
Sinorhizobium_medicae	KKPT	GTLVLDAL	VPGRRLYMFS	TGTGIAPF		
Agrobacterium_tumefaciens	KKPT	GTLVLDAL	TPGRRLYMFS	TGTGIAPF		
Rhizobium_leguminosarum	KKPT	GTLVLDAL	TPGRRLYMFS	TGTGIAPF		
Rhizobium_etli	KKPT	GTLVLDAL	TPGRRLYMFS	TGTGVAPF		
Stappia_aggregata	KKPT	GTLVNDAL	IPGKRVYMFS	TGTGIAPF		
Hyphomonas_neptunium	RKPT	GTLVLDAL	TPGKRLYMFS	TGTGFAPF		
Rhodobacter_sphaeroides	PKPV	GTLVLDAL	LLPGKRIWFLA	TGTGIAPF		
Paracoccus_denitrificans	PKPV	GTLVLDAL	LLPGKRMWFLA	TGTGIAPF		
Rhodobacter_capsulatus	PKPV	GTLVIDAL	LLPGKRLWFLA	TGTGIAPF		
Jannaschia_sp.	PKPV	GTLVHDAL	LLPGKRLWFFA	TGTGFAPF		
Loktanella_vestfoldensis	PKPV	GTLVHDAL	LLPGKRLWFFA	TGTGFAPF		
Dinoroseobacter_shibae	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Phaeobacter_gallaeciensis	PKPV	GTLVHDAL	IPGKRIWFFA	TGTGFAPF		
Silicibacter_sp.	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Sagittula_stellata	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Oceanicola_batsensis	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Roseovarius_sp.	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Roseobacter_denitrificans	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Roseobacter_litoralis	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Roseovarius_nubinihibens	PKPV	GTLVHDAL	LLPGKRLWFFA	TGTGFAPF		
Silicibacter_pomeroyi	PKPV	GTLVHDAL	LLPGKRIWFFA	TGTGFAPF		
Sulfitobacter_sp.	PKPV	GTLVHDAL	LLPGKRLWFLA	TGTGFAPF		
Oceanibulbus_indolifex	PKPV	GTLVHDAL	LLPGNRLWMFA	TGTGFAPF		
Rhodocerales_bacterium	PKPV	GTLVHDAL	TPGKRLWFFA	TGTGFAPF		
Oceanicola_granulosus	PKPV	GTLVHDAL	LLPGKRLYFFS	TGTGFAPF		
Burkholderia_dolosa	KKPT	GTLVVDNLL	PGKTLWLLS	TGTGLAPF		
Burkholderia_multivorans	KKPT	GTLVVDNLL	PGKTLWLLS	TGTGLAPF		
Burkholderia_cenocepacia	KKPT	GTLVADNLL	PGKTLWMLS	TGTGLAPF		
Burkholderia_ambifaria	KKPT	GTLVADNLL	PGKTLWMLS	TGTGLAPF		
Burkholderia_vietnamiensis	KKPT	GTLVADNLL	PGKTLWMLS	TGTGLAPF		
Burkholderia_ubonensis	KKPT	GTLVADNLL	PGKTLWMLS	TGTGLAPF		
Burkholderia_thailandensis	KKPT	GTLVADNLL	PGKTLWLLS	TGTGLAPF		
Burkholderia_pseudomallei	KKPT	GTLVADNLL	PGKTLWLLS	TGTGLAPF		
Burkholderia_oklahomensis	KKPT	GTLVADNLL	PGKTLWLLS	TGTGLAPF		
Hahella_chejuensis	RKPT	GTLVVDHLL	PGRNLYLIS	TGTGLAPF		
Reinekea_sp.	SKPT	GTLIVDNLL	PGRNLYMIS	TGTGLAPF		
Pseudomonas_putida	KKPT	GTLVLDLNP	PGKHLYLLS	TGTGLAPF		
Pseudomonas_entomophila	KKPT	GTLVLDLNP	PGKHLYLLS	TGTGLAPF		
Pseudomonas_fluorescens	KKPT	GTLVLDLNP	PGKHLYLLS	TGTGLAPF		
Pseudomonas_mendocina	KKPT	GTLVLDLNP	PGKHLYLLS	TGTGLAPF		
Ralstonia_eutropha	KKPT	GTLVLDNLL	PGKTLWLLA	TGTGLAPF		
Cupriavidus_taiwanensis	KKPT	GTLVLDNLL	PGKTLWLLA	TGTGLAPF		
Methylobacterium_radiotolerans	KKPT	GTLVLDNLL	PGRHLYLLG	TGTGLAPF		
Methylobacterium_extorquens	KKPT	GTLVLDNLL	PGKNLYLLG	TGTGLAPF		
Methylobacterium_nodulans	RKAT	GTLVLDNLL	PGRHLYLLG	TGTGLAPF		
Xanthobacter_autotrophicus	RKPT	GTLVQDSL	LLPGKRLYLLS	TGTGLAPF		
Brucella_melitensis	KKPV	GTLLYDNL	KPGKHLWLLS	TGTGLAPF		
Brucella_ovis	KKPV	GTLLYDNL	KPGKHLWLLS	TGTGLAPF		
Brucella_suis	KKPV	GTLLYDNL	KPGKHLWLLS	TGTGLAPF		
Ochrobactrum_anthropi	KKPV	GTLLYDNL	KPGKNLWLLS	TGTGLAPF		
Psychrobacter_arcticus	KKPT	GTLVLDL	LLPGKNLYMLS	TGTGVAPF		
Psychrobacter_cryohalolentis	KKPT	GTLVLDL	LLPGKNLYMLS	TGTGVAPF		
Psychrobacter_sp.	KKPT	GTLVVDL	LLPGKNLYMLS	TGTGLAPF		
Caulobacter_crescentus	KKPT	GTLVLD	AVRPGKRLFLFG	TGTGLAPF		
consensus	*	***	*	*	***	**

	130	140	150
Oceanicaulis_alexandrii	ASVIRDPETYERFDQVILTHTC	REVAELTY	
Maricaulis_maris	ASLIRDPETYEKFDQVILTHTC	REAAELTY	
Mesorhizobium_lotii	ASLLRDPDTYEKFDQLILTHTC	RDNAELTY	
Mesorhizobium_sp.	ASLIRDPETYEKFEQVILTHTC	RDVAELTY	
Aurantimonas_sp.	ASVIRDPETYEKFDQVILTQTC	RGNAELAY	
Fulvimarina_pelagi	ASVIRDPETYEKFDQVILTQTC	REDSELEY	
Bartonella_quintana	ASLIRDPETYEKFEVLIQTT	RRERDELTY	
Bartonella_henselae	ASLIRDPETYEKFEVLIQTT	RECDELNY	
Bartonella_tribocorum	ASLIRDPDTYEKFEVLIQTT	REKNELEY	
Bartonella_bacilliformis	ASLIRDPETYEKFSQVLIQTT	RECNELEY	
Hoeflea_phototrophica	ASLVDRDPETYDKFEEVILTHTC	RDADDELQY	
Sinorhizobium_meliloti	ASLIRDPETFEEKFEEVILTHTC	RDVAELKY	
Sinorhizobium_medicae	ASLIRDPETFEEKFEEVILTHTC	RDVAELKY	
Agrobacterium_tumefaciens	ASLIRDPETYEKFEVILTHTC	RDVAELKY	
Rhizobium_leguminosarum	ASLIRDPETYEKFEVILTHTT	RDVAELKY	
Rhizobium_etli	ASLIRDPETYEKFEVILTHTT	RDVAELKY	
Stappia_aggregata	ASLIRDPDTYEKFDQVILTHTC	REVAELKY	
Hyphomonas_neptunium	ASLVDRDPDTYERYDEVIVTHTC	RDVDELITY	
Rhodobacter_sphaeroides	ASLMRDPETYERYEQVIMMHTC	REOAELEY	
Paracoccus_denitrificans	ASLMRDPETYERYEQVMMHTC	RTADELAY	
Rhodobacter_capsulatus	ASLMREPEAYEKFDEVIMMHAC	RTVAELEY	
Jannaschia_sp.	ASLLREPQTYEDYDEIITHTC	REVGELTY	
Loktanelia_vestfoldensis	ASLLREPQTYEDYDEIITHTC	RELGELTY	
Dinoroseobacter_shibae	ASLLREPQTYEDYDEVIITHTC	REAGELDY	
Phaeobacter_gallaeciensis	ASLLREPQTYEKFDEVIITHTC	REAGELTY	
Silicibacter_sp.	ASLLREPQTYEDYDEVIITHTC	REVGELTY	
Sagittula_stellata	ASLLREPQTYEDYDEVIITHTC	REAAELHY	
Oceanicola_batsensis	ASLLRDPQTYEDYDEVIITHTC	REVGELAY	
Roseovarius_sp.	ASLLRDPQTYSDYDEVIITHTC	RELGELQY	
Roseobacter_denitrificans	ASLLRDPQTYEDYDEVIITHTC	REVGELKY	
Roseobacter_litoralis	ASLLRDPQTYEDYDEVIITHTC	REVGELQY	
Roseovarius_nubinihibens	ASLLREPQTYHDYDEVIITHTC	RGADELKY	
Silicibacter_pomeroyi	ASLLREPQTYEDYDEVIITHTC	REVAELEY	
Sulfitobacter_sp.	ASLLREPQTYEKFDQIIMTHTT	RDVAELDY	
Oceanibulbus_indolifex	ASLLREPQTYEKFDEVIVTHTC	RDVAELEY	
Rhodobacterales_bacterium	ASLLRDPETYEERFDQVIVTHTC	RDVAELEY	
Oceanicola_granulosus	ASLLRDPETYEAYDEVIVTHTC	RDVAELEY	
Burkholderia_dolosa	MSIIRDPEIYDRFDKVVLTHTC	RLKGELAY	
Burkholderia_multivorans	MSIIRDPEIYDRFEKVVLTHTC	RLKGELAY	
Burkholderia_cenocepacia	MSIIRDPEIYDRFDKVVLTHTC	RLKGELAY	
Burkholderia_ambifaria	MSIIRDPEIYDRFDKVVLTHTC	RLKGELAY	
Burkholderia_vietnamiensis	MSIIRDPEIYERFDKVVLTHTC	RLKGELAY	
Burkholderia_ubonensis	MSIIRDPEIYERFDKVVLTHTC	RLKGELAY	
Burkholderia_thailandensis	MSIIRDPEIYERFDKVVLTHTC	RLKGELAY	
Burkholderia_pseudomallei	MSIIRDPEIYERFEKVVLTHTC	RLKGELAY	
Burkholderia_oklahomensis	MSIIRDPEIYERFDKVVLTHTC	RLKGELAY	
Hahella_chejuensis	MSI IKDPETYEERFDKVVLTHTC	RYVSELAY	
Reinekea_sp.	MSVIKDPPEVYEQYDKVILTHGV	RTVDELAY	
Pseudomonas_putida	MSVIQDPETYEERFEKVVILVHGV	RYVNEVAY	
Pseudomonas_entomophila	MSVIQDPETYEERFEKVVILVHGV	RYVNEVAY	
Pseudomonas_fluorescens	MSVIQDPETYEERFEKVVILVHGV	RYVNEVAY	
Pseudomonas_mendocina	MSVIQDPETYEERFEKVVILVHGV	RYVNEVAY	
Ralstonia_eutropha	LSIIRDPEVYERYDKVVLTHTC	RFVEELAY	
Cupriavidus_taiwanensis	LSIIRDPEVYERYDRVVLTHTC	RFVEELAY	
Methylobacterium_radiotolerans	LSI IKDPETYDRFEKVVLVHGC	ROVQELAY	
Methylobacterium_extorquens	LSI IKDPETYDRFEKVVLVHGC	ROVQELAY	
Methylobacterium_nodulans	LSI IKDPETYEERFEKVVLVHGC	ROVQELAY	
Xanthobacter_autotrophicus	LSVVKDPEAYERFEKVVILIHGT	RTVAELAY	
Brucella_melitensis	LSIIRDLEVYERFEKVVILVHGV	ROVAELAY	
Brucella_ovis	LSIIRDLEVYERFEKVVILVHGV	ROVAELAY	
Brucella_suis	LSIIRDLEVYERFEKVVILVHGV	ROVAELAY	
Ochrobactrum_anthropi	LSIIRDLEAYERFEKVVILVHGV	ROVAELAY	
Psychrobacter_arcticus	LALARDPEVYERFEKVVILVHGV	RGVSDLAY	
Psychrobacter_cryohalolentis	LALARDPEVYERFEKVVILVHGV	RGISDLAY	
Psychrobacter_sp.	LSLSRDPEVYERFEKVVILVHGV	RKVEDLAY	
Caulobacter_crescentus	LSVARDPDAYS RFERFVIVAHGV	REVKELAY	
consensus		*	*

	160	170	180
Oceanicaulis_alexandrii	GKELVETVREDPLVGEFVG....	DKLVYYP	
Maricaulis_maris	GNELVAAVKDDELIGEFAR....	EKLVHFA	
Mesorhizobium_loti	GQELVAALES DPLIGELTTG...	R.VTLYN	
Mesorhizobium_sp.	GEELVAATREDPLIGEFTLG...	R.LHHFT	
Aurantimonas_sp.	GRELVETSKADELMSEFIGD...	K.LIFHA	
Fulvimarina_pelagi	GRQLVDHMKTDELMQEVVGE...	KELLFHA	
Bartonella_quintana	AKDLVDSLQODPLIGEYV....	KQLKFYP	
Bartonella_henselae	AKDLVSVLQODPLIGEYA....	PQLKFYP	
Bartonella_tribocorum	AKDLVCSLQODPLIGTYA....	QQLKFYP	
Bartonella_bacilliformis	AKDLVASLQODSLIGEYA....	QQLMFYP	
Hoeflea_phototrophica	GMDLVRECREDPVLVGEFAG...	DRLKHYA	
Sinorhizobium_meliloti	GFDLVDEIRNHEFLNEIVG....	DKLRHYA	
Sinorhizobium_medicae	GFDLVDEIRNHEFLNEVVG....	NKLRHYA	
Agrobacterium_tumefaciens	GFDLVVEEIRNHEFLNEIVG...	DKLKHYA	
Rhizobium_leguminosarum	GFDLVVEEIQNDELLKEVVG...	DKLRHYA	
Rhizobium_etli	GFDLVHEIQNDELLKEVVG....	DKLRHYA	
Stappia_aggregata	GEDLVQETINDPLIGEFAG...	DKLVHYT	
Hyphomonas_neptunium	SRTLIDSLHNDPLVGMVE....	GKLLKLT	
Rhodobacter_sphaeroides	GRQLVESLKD DPLIGEMVG...	DKLLYYP	
Paracoccus_denitrificans	GRELVENLRHDPLLGELYGEEFASRLLYYP		
Rhodobacter_capsulatus	GRQLVEALQEDPLIGELVEG...	KLKYYP	
Jannaschia_sp.	GRDLIAALQHDPELLNEVIGDGFWKKIKYYP		
Loktanella_vestfoldensis	GRDLIEGLKTDELLNEVIGDGFWKKIKYYP		
Dinoroseobacter_shibae	GREVIESLKTDELLNEVIGDGFWKKIKYYP		
Phaeobacter_gallaeciensis	GRELIESLKDDELLNEVIGEGFWKKIKYYP		
Silicibacter_sp.	GRELIESLKEDELLNEVIGEGFWKKIKYYP		
Sagittula_stellata	GAELIEGLKTDELLNEVIGEGFWKKIKYYP		
Oceanicola_batsensis	GAELIDGIRKDELLNELIGADNLSKLRYP		
Roseovarius_sp.	GADLIESIRNDEMLAELIGEGFADKLRYP		
Roseobacter_denitrificans	GADLIESIKADELLNELIGEDNLKLRYP		
Roseobacter_litoralis	GADLIESIKADELLNELIGEDYLKLRYP		
Roseovarius_nubinihibens	GAALIDSIRNDEMLAELIGEGFADKIRYP		
Silicibacter_pomeroyi	GRQLIEEIRODELLAELMGEFADKIRYP		
Sulfitobacter_sp.	GRTLVESSLADDPLIGEMIG....	DKLVYYP	
Oceanibulbus_indolifex	GRQLIEGLKSDELMOELIGTENLAKIRYP		
Rhodobacterales_bacterium	GRQLVENLADDPLIGEFIG....	NKLTYP	
Oceanicola_granulosus	GRTLIDNLRAD EMMQELLG.DGLDKLRYP		
Burkholderia_dolosa	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_multivorans	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_cenocepacia	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_ambifaria	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_vietnamiensis	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_ubonensis	MDYIKHDLPGHEYLGDIK....	EKLVYYP	
Burkholderia_thailandensis	MDYIKHDLPGHEYLG EVIR....	EKLVYYP	
Burkholderia_pseudomallei	MDYIKHDLPGHEYLG DVIR....	EKLVYYP	
Burkholderia_oklahomensis	MDFIKHDLPGHEYLG DVIR....	EKLVYYP	
Hahella_chejuensis	QELIRDEL P QNEFFGELVQ....	EKLIYYP	
Reinekea_sp.	QDLIRDEL P TNEYFGDLVR....	EKLIYYP	
Pseudomonas_putida	REFITEHL P QNEFFGESVR....	DKLIYYP	
Pseudomonas_entomophila	REFITEHL P QNEFFGESVR....	DKLIYYP	
Pseudomonas_fluorescens	REFITEHL P QNEFFGEALR....	DKLIYYP	
Pseudomonas_mendocina	REFITEHL P RNEFFGDALK....	EKLIYYP	
Ralstonia_eutropha	RELIOEHL P QHEHLGDLVR....	EKLVYFP	
Cupriavidus_taiwanensis	RELIOEHL P QHEHLGEMVR....	EKLVYFP	
Methylobacterium_radiotolerans	GETITEAL P NHEFLGEMIA....	AQLVYYP	
Methylobacterium_extorquens	GETITETLP KHEFLGEMIA....	NQLIYYP	
Methylobacterium_nodulans	GETITQDLP NHELIGEMVR....	TQLIYYP	
Xanthobacter_autotrophicus	DEFLTKELP NHEFLGDEV R....	NKLIYYP	
Brucella_melitensis	TDFISNEL P QDEFLGEMVK....	NQLIYYP	
Brucella_ovis	TDFISNEL P QDEFLGEMVK....	NQLIYYP	
Brucella_suis	TDFISNEL P QDEFLGEMVK....	NQLIYYP	
Ochrobactrum_anthropi	TDFIANEL P QDEFLGEMVK....	NQLIYYP	
Psychrobacter_arcticus	RDMFENEL P NDEIFGEDFR....	KKFIYYP	
Psychrobacter_cryohalolentis	RDMFENEL P NDEIFGEDFR....	KKFIYYP	
Psychrobacter_sp.	REMFEETLP NDELFG EWYR....	EKFIYYP	
Caulobacter_crescentus	RDLFTQEIFDDPLV GDEAR....	AQLTYYP	
consensus			



	190	200	210
Oceanicaulis_alexandrii	SV	TREEFERKGRIT	QLMDDGVIYEELGIPP
Maricaulis_maris	SV	TREEGPIKGRVT	DMIESGELFERLGVPP
Mesorhizobium_loti	ST	TREESARMGRIT	TALIGSGKFYADLGIDK
Mesorhizobium_sp.	ST	TREASDHVGRIT	TLVENGKLFQALGTEP
Aurantimonas_sp.	SAT	RDGETRGRHRT	TLIENGKLFEDLAIAP
Fulvimarina_pelagi	TAT	QKGEVTGDRVT	KLIENGKLFIDLAIAP
Bartonella_quintana	MT	TRESSKHMGRIT	TVMESGAFFETTGLPK
Bartonella_henselae	MT	TRESSEHMGRIT	TVMESGAFFEMTGLPK
Bartonella_tribocorum	MT	TRESSEHMGRIT	TVMESGCFEETTGLPK
Bartonella_bacilliformis	MT	TREPSEHMGRIT	TVMKSGAFFEETTGLPK
Hoeflea_phototrophica	TC	TRETYPFMGRIT	DLMASGKLFIDLGLPP
Sinorhizobium_meliloti	TV	TREYYPFKGRIT	DLMTNGKFFADLGLPP
Sinorhizobium_medicae	TV	TREDYSYKGRIT	DLMNNGKFFADLGLQP
Agrobacterium_tumefaciens	TV	TREDYYPFKGRIT	TLIENGKLFADLGVPA
Rhizobium_leguminosarum	TV	TREDFEYRGRIT	DLISSGKLFIDLGVPP
Rhizobium_etli	TV	TREDFAYRGRIT	DLISSGKLFIDLGVPP
Stappia_aggregata	SV	TREDFPRQGRIT	DLIKSGKLFEDLGVPP
Hyphomonas_neptunium	TT	TREHYEHMGRIT	TLIENGKLFEDLGVPP
Rhodobacter_sphaeroides	TT	TRETSDRMGRIT	DNLSSGKVFADLGVPK
Paracoccus_denitrificans	TT	TREETPYMGRIT	DNLTSGKVFADLNLPP
Rhodobacter_capsulatus	TT	TREEFHMMGRIT	DNLASGKVFEDLGIAP
Jannaschia_sp.	TT	TREESPKMGRIT	DLMRSGEAFSDLGVAP
Loktanelia_vestfoldensis	TT	TREDSPKMGRIT	DLMRSGEAFSDLGVVP
Dinoroseobacter_shibae	TT	TREQSPKMGRIT	DLMKSGECFSDLVVPV
Phaeobacter_gallaeciensis	TT	TREESAKMGRIT	DLMRSGEAFADLGVPP
Silicibacter_sp.	TT	TREESAKMGRIT	DLMRSGEAFADLGVPP
Sagittula_stellata	TT	TREESPKMGRIT	DLMRSGEAFRDLDGVPD
Oceanicola_batsensis	TT	TREESPRMGRIT	DRMRSGEVFTDLGVPE
Roseovarius_sp.	TT	TREESPKMGRIT	DLMRSGEVFDLGVAP
Roseobacter_denitrificans	TT	TREESPKMGRIT	DLMRSGDVFDLGVAP
Roseobacter_litoralis	TT	TREESPKMGRIT	DLMRSGDVFDLGVSP
Roseovarius_nubinihibens	TT	TREESPKMGRIT	DLLRKGEVFDLGDIDP
Silicibacter_pomeroyi	TT	TREESPRMGRIT	TELLKDGTVFADLGDIG
Sulfitobacter_sp.	TT	TREQSPKMGRIT	TNLLQDGTVFKDLGDIG
Oceanibulbus_indolifex	TT	TREESPKMGRIT	TNLLQDGSVFKDLGVPO
Rhodobacterales_bacterium	TT	TREESPKMGRIT	TLLSDGTVFNDLGIET
Oceanicola_granulosus	TT	TREESPKMGRIT	TLLIESAELFADLGVPA
Burkholderia_dolosa	TV	TREAFDNEGRI	DLIASGKLFIDLGVA.
Burkholderia_multivorans	TV	TREAFDNEGRI	DLIASGKLFIDLGVA.
Burkholderia_cenocepacia	TV	TREAFDNEGRI	DLIATGKLFIDLGVV.
Burkholderia_ambifaria	TV	TREAFDNEGRI	DLIATGKLFIDLGVV.
Burkholderia_vietnamiensis	TV	TREAFDNEGRI	DLIATGKLFIDLGVA.
Burkholderia_ubonensis	TV	TREEFENEGRI	DLISTGKLFADLDVP.
Burkholderia_thailandensis	TV	TREEFENEGRI	DLIASGKLFADLDVP.
Burkholderia_pseudomallei	TV	TREEFENEGRI	DLIASGKLFADLDVP.
Burkholderia_oklahomensis	TV	TREEFENEGRI	DLISSGKLFADLDVP.
Hahella_chejuensis	TV	TREDYPTQGRIT	DLMESGKLFSDLGLP.
Reinekea_sp.	TV	TRESYENMGRIT	TELMENGKLFSDIGLP.
Pseudomonas_putida	TV	TREPFENQGRIT	DLMRSKGLFSDIGLP.
Pseudomonas_entomophila	TV	TREPFENQGRIT	DLMRSKGLFSDIGLP.
Pseudomonas_fluorescens	TV	TREPFENQGRIT	DLMRSKGLFSDIGLP.
Pseudomonas_mendocina	TV	TREPFENQGRIT	DLMRSKGLFADIGLP.
Ralstonia_eutropha	TV	TREEFDNRGRIT	DLIASGELFERLGVE.
Cupriavidus_taiwanensis	TV	TREEFDNRGRIT	DLIASGELFERLDMA.
Methylobacterium_radiotolerans	TV	TREPFRNRGRIT	DLMVSGKLFEDIGLP.
Methylobacterium_extorquens	TV	TREPFRNRGRIT	DLMTSGKLFEDIGLP.
Methylobacterium_nodulans	TV	TREPFRNRGRIT	DLITSGKLFEDVGLP.
Xanthobacter_autotrophicus	TV	TREPFRNQGRIT	DLITSGKLFADLGLP.
Brucella_melitensis	TV	TREPYKNRGRIT	DLIRSGQLFKDVGLP.
Brucella_ovis	TV	TREPYKTRGRIT	DLIRSGQLFKDVGLP.
Brucella_suis	TV	TREPYKNRGRIT	DLIRSGQLFKDVGLP.
Ochrobactrum_anthropi	TV	TREPYKNRGRIT	DLIRSGQLFTDIGLP.
Psychrobacter_arcticus	TV	TREEFRNTGRIT	DLMKSGKFFEDIGLP.
Psychrobacter_cryohalolentis	TV	TREEFRNTGRIT	DLMKSGKFFEDIGLP.
Psychrobacter_sp.	TV	TREDFRNTGRIT	DLMRSKGLYEDIGLP.
Caulobacter_crescentus	TV	TREAFERQGRIT	DLITSGKLFQDLGIEG
consensus		* * *	

Oceanicaulis_alexandrii	...	LNPET	DRVMI	CG	SMDMLES	CKQRCE	.Q
Maricaulis_maris	...	LDPES	DRVMI	CG	SEGLLRDVKQICL		.D
Mesorhizobium_loti	...	LNPET	DRIMI	CG	SMHMLKDVKELAE		.S
Mesorhizobium_sp.	...	FNPAN	DRIMI	CG	SMAMLKDVKALAE		.K
Aurantimonas_sp.	...	LNPET	DRAMIC	CG	SMAMLKDTKALAE		.A
Fulvimarina_pelagi	...	LDPAN	DRAMIC	CG	SMAMLKDTKELLQ		.E
Bartonella_quintana	...	IHSNE	DRVMI	CG	SMAMLKDCARMCE		.S
Bartonella_henselae	...	IHADE	DRVMI	CG	SMAMLKDCARMCE		.V
Bartonella_tribocorum	...	IHPDE	DRVMI	CG	SMAMLKDCARMCE		.S
Bartonella_bacilliformis	...	INSDE	DRVMI	CG	SIEMIKDCAAMCE		.D
Hoeflea_phototrophica	...	LSPET	DRGMI	CG	SMEMLKDTKALAE		.G
Sinorhizobium_meliloti	...	LDPEI	DRGMI	CG	STAMLKDTKEILE		.A
Sinorhizobium_medicae	...	LDPVI	DRGMI	CG	STAMLKDTKEILE		.A
Agrobacterium_tumefaciens	...	LDPAI	DRGMI	CG	SSAMLKDTKELLE		.K
Rhizobium_leguminosarum	...	LDPAI	DRGMI	CG	SSAMLKDTKELLE		.K
Rhizobium_etli	...	LDPAI	DRGMI	CG	SSAMLKDTKELLE		.K
Stappia_aggregata	...	LDPAV	DRGMI	CG	SMDMLKDTKALLE		.E
Hyphomonas_neptunium	...	LDPAT	DRAMIC	CG	SMEMIQDVKALML		.K
Rhodobacter_sphaeroides	...	MNLEE	DRAMVC	CG	SLOFNLDVKTVLE		.S
Paracoccus_denitrificans	...	MDAAN	DRAMIC	CG	SLAFNTDVKTVLE		.G
Rhodobacter_capsulatus	...	MNPET	DRAMVC	CG	SLAFNVDMKVLE		.S
Jannaschia_sp.	...	LNAET	DRAMIC	CG	NLAFNLELKDMFE		.D
Loktanella_vestfoldensis	...	LSPGT	DRAMIC	CG	NLAFNLELKEMLE		.S
Dinoroseobacter_shibae	...	LCPET	DRAMIC	CG	NLAFNLELKDMLE		.S
Phaeobacter_gallaeciensis	...	LNPEI	DRAMIC	CG	NLAFNLELKDLFENT		.G
Silicibacter_sp.	...	LNPEI	DRAMIC	CG	NLAFNLELKDLFENT		.G
Sagittula_stellata	...	INPDT	DRAMIC	CG	NLAFNLELKAMLE		.E
Oceanicola_batsensis	...	ISPEN	DRAMVC	CG	NLAFNLEIKELLE		.G
Roseovarius_sp.	...	LSPET	DRAMVC	CG	NLAFNLEIKDMLE		.G
Roseobacter_denitrificans	...	MSPET	DRAMVC	CG	NLAFNLEIKDLLE		.G
Roseobacter_litoralis	...	MSPET	DRAMVC	CG	NLAFNLEIKDLLE		.G
Roseovarius_nubinihibens	...	IAPET	DRAMIC	CG	NLAFNLELKDLLE		.E
Silicibacter_pomeroyi	...	GKAET	DRAMVC	CG	SLAFNHDKAILE		.G
Sulfitobacter_sp.	...	ISADT	DRGMV	CG	SLEFNKDIKDVLE		.G
Oceanibulbus_indolifex	...	INATH	DRAMVC	CG	SLGFNKDIMEILE		.G
Rhodobacterales_bacterium	...	ITADT	DRAMVC	CG	SMGLNNDIKEILE		.G
Oceanicola_granulosus	...	LDPAT	DRAMVC	CG	SLEFNKDIKALLE		.A
Burkholderia_dolosa	.P.	FSPEN	DRVML	CG	STAMLKDTTALLK		.E
Burkholderia_multivorans	.P.	FSPEN	DRVML	CG	STAMLKDTTALLK		.Q
Burkholderia_cenocepacia	.A.	FSPEN	DRVML	CG	STAMLKDTTELLK		.Q
Burkholderia_ambifaria	.A.	FSPEN	DRVML	CG	STAMLKDTTDLK		.Q
Burkholderia_vietnamiensis	.P.	FSPEN	DRVML	CG	STAMLKDTTDLK		.Q
Burkholderia_ubonensis	.P.	FSPEN	DRVML	CG	STAMLKDTTDLK		.Q
Burkholderia_thailandensis	.P.	FSPEN	DRVML	CG	STAMLKDTTELLK		.K
Burkholderia_pseudomallei	.P.	FSPER	DRVML	CG	STAMLKDTTELLK		.K
Burkholderia_oklahomensis	.P.	FSPEN	DRVML	CG	STAMLKDTVELLK		.K
Hahella_chejuensis	.A.	MDPEH	DRFMV	CG	SPSMLKDTCSILD		.S
Reinekea_sp.	.D.	MDPEH	DRFMV	CG	SPSMLKDTCKILD		.A
Pseudomonas_putida	.P.	INPQD	DRAMIC	CG	SPSMLDETSEVLD		.S
Pseudomonas_entomophila	.P.	INPQD	DRAMIC	CG	SPSMLDETSEVLD		.S
Pseudomonas_fluorescens	.P.	INPQD	DRAMIC	CG	SPSMLDETSEVLD		.S
Pseudomonas_mendocina	.P.	INPQD	DRAMIC	CG	SPSMLDETSAVLD		.S
Ralstonia_eutropha	.P.	FSLN	DRIML	CG	SPDMLKDVRAILE		.E
Cupriavidus_taiwanensis	.P.	FSTEN	DRIML	CG	SPDMLKDVRAILE		.A
Methylobacterium_radiotolerans	.P.	MSIEA	DRFML	CG	SPDMIRDRELLT		.S
Methylobacterium_extorquens	.N.	MSIEN	DRFML	CG	SPMIKDTREMLT		.S
Methylobacterium_nodulans	.P.	MTIEA	DRFML	CG	SPDMIRDRELLS		.S
Xanthobacter_autotrophicus	.V.	ISPEE	DRMLL	CG	SPQMLKDVVDLLE		.S
Brucella_melitensis	.E.	FNHED	DRMML	CG	SPMLAETKQILE		.E
Brucella_ovis	.E.	FNHED	DRMML	CG	SPMLAETKQILE		.E
Brucella_suis	.E.	FNHED	DRMML	CG	SPMLAETKQILE		.E
Ochrobactrum_anthropi	.E.	FNHDD	DRMML	CG	SPMLAETKQILE		.E
Psychrobacter_arcticus	.P.	MNKED	DRVLI	CG	SMPFNAEVSAILD		.D
Psychrobacter_cryohalolentis	.P.	MNKED	DRVLI	CG	SMPFNAEVSAILN		.D
Psychrobacter_sp.	.P.	INKED	DRVMI	CG	SMPFNADISEILD		.A
Caulobacter_crescentus	DR.	FDPEN	DRAML	CG	SMAMIKDTAALLE		.A
consensus			**	**			

	240	250
Oceanicaulis_alexandrii	AGLK. EGSNARPAQYVV	EKSFVVG...
Maricaulis_maris	RNFV. EGSNAAPADFVV	EKAFFVAT..
Mesorhizobium_loti	LGFO. EGSLSHPATFVV	ERAFVVG...
Mesorhizobium_sp.	AGLK. EGSNAEPADFVV	ERAFVVG...
Aurantimonas_sp.	RGFE. EGANNKPGTFVV	ERAFVVD...
Fulvimarina_pelagi	RGFE. EGANNAPGTYYVV	ERAFVVD...
Bartonella_quintana	FGLV. EGANNAPATYYVV	ERAFVVG...
Bartonella_henselae	FGLV. EGANNAPATYYVV	ERAFVVG...
Bartonella_tribocorum	FGLV. EGANNAPATYYVV	ERAFVVE...
Bartonella_bacilliformis	FGLV. EGANNAPATYYVV	ERAFVVG...
Hoeflea_phototrophica	FGLE. EGANNRPSTFVV	ERAFVVG...
Sinorhizobium_meliloti	AGLT. EGANNKPAEFVI	ERAFVVG...
Sinorhizobium_medicae	AGLT. EGANNKPAEFVI	ERAFVVG...
Agrobacterium_tumefaciens	AGLN. EGANNKPAEFVI	ERAFVVG...
Rhizobium_leguminosarum	GGLN. EGANSKPAEFVI	ERAFVVG...
Rhizobium_etli	AGLN. EGANSKPAEFVI	ERAFVVG...
Stappia_aggregata	AGLT. EGANNKPAEFVV	ERAFVVG...
Hyphomonas_neptunium	AGLT. EGSNAAPAEFVI	EKAFFAG...
Rhodobacter_sphaeroides	FGLR. EGANSEPLQYVV	EKAFFVGDGI
Paracoccus_denitrificans	FGLR. EGANSDPKEFVV	EKAFFVGDGI
Rhodobacter_capsulatus	YGLR. EGANSEPREFVV	EKAFFVGEGI
Jannaschia_sp.	YGLE. EGANSKPAHYVV	EKAFFLD...
Loktanelia_vestfoldensis	YGLN. EGANSNPQYVV	EKAFFLD...
Dinoroseobacter_shibae	YGLE. EGANSKPAHYVV	EKAFFLD...
Phaeobacter_gallaeciensis	YGLE. EGANSKPAHFVV	EKAFFLD...
Silicibacter_sp.	YGLE. EGANSKPAHFVV	EKAFFLD...
Sagittula_stellata	YGLE. EGANSDPKQYVV	EKAFFLD...
Oceanicola_batsensis	YGLR. EGANSDPKEYVV	EKAFFVD...
Roseovarius_sp.	YGLR. EGANSDPKEYVV	EKAFFLD...
Roseobacter_denitrificans	YGLE. EGANSKPAQYVV	EKAFFLD...
Roseobacter_litoralis	YGLE. EGANSKPAQYVV	EKAFFLD...
Roseovarius_nubinihibens	FGLK. EGANSDPQTYVV	EKAFFLD...
Silicibacter_pomeroyi	FGLT. EGANSDPREFVI	EKAFFVG...
Sulfitobacter_sp.	FGLE. EGANSDPKHYVV	EKAFFVG...
Oceanibulbus_indolifex	FGLT. EGANSDPQHVV	EKAFFVG...
Rhodobacterales_bacterium	FGLR. EGANSDPAEYVV	EKAFFVG...
Oceanicola_granulosus	HGLR. EGANSDPAEFVV	EKAFFVG...
Burkholderia_dolosa	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_multivorans	AGLV. EGKNNAPGHYVI	ERAFVVD...
Burkholderia_cenocepacia	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_ambifaria	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_vietnamiensis	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_ubonensis	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_thailandensis	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_pseudomallei	AGLV. EGKNSAPGHYVI	ERAFVVD...
Burkholderia_oklahomensis	AGLV. EGKNSAPGHYVI	ERAFVVD...
Hahella_chejuensis	RGFT. EARQDGLGHYVI	ERAFVVES..
Reinekea_sp.	RGFK. EAKQGEGLGHYVI	ERAFVVES..
Pseudomonas_putida	FGLKI SPRMREPGDYLI	ERAFVEK..
Pseudomonas_entomophila	FGLKI SPRMREPGDYLI	ERAFVEK..
Pseudomonas_fluorescens	FGLKI SARMPREPGDYLI	ERAFVEK..
Pseudomonas_mendocina	FGLKI SPRMREPGDYLI	ERAFVEK..
Ralstonia_eutropha	RGFA. EGNM SHPGHFVL	EKAFFVG...
Cupriavidus_taiwanensis	RGFA. EGNM SHPGHFVL	EKAFFVG...
Methylobacterium_radiotolerans	RGYE. EGNHGEAGHYVI	EKAFFVEK..
Methylobacterium_extorquens	LGYE. EGNHGEAAHYVI	EKAFFVEK..
Methylobacterium_nodulans	RGYI. EGNHGEAGHYVI	EKAFFVEK..
Xanthobacter_autotrophicus	RGFA. EGSQSAPGHYVI	EKAFFVER..
Brucella_melitensis	RGFT. EGSQSEPGEFVI	EKAFFVEK..
Brucella_ovis	RGFT. EGSQSEPGEFVI	EKAFFVEK..
Brucella_suis	RGFT. EGSQSEPGEFVI	EKAFFVKK..
Ochrobactrum_anthropi	RGFK. EGSQSEAGHYVI	EKAFFVEK..
Psychrobacter_arcticus	FGLTVSPRMGVQADYAV	ERAFVVG...
Psychrobacter_cryohalolentis	FGLTVSPRMGVQADYAV	ERAFVVG...
Psychrobacter_sp.	AGLTVSPRMGVPADYVV	ERAFVVG...
Caulobacter_crescentus	QGLK. EGSNAEPGDFVI	ERAFVVG...
consensus		* * *

## Alignment of Plant FNRs

	10	20	30
Nostoc_commune	..MLERMYNQGAVEGAANTELG	.SRIFLYEVVGLR	
Nostoc_punctiforme	.....MYNQGAVEGAANIELG	.SRIFVYEVVGLR	
Anabaena	.....	.....	.....
Nodularia_spumigena	..MLERMYNQGAVEGAANRELG	.SRVFVYEVVGLR	
Arthrospira_platensis	.....MYSPTGTGVAMRTGAA	.GRIFVFEVEGMR	
Lyngbya_sp.	.....MYSPSGSGVATKTGAN	.SRVFVFEVEGMR	
Trichodesmium_erythraeum	MMEKQIMKTDMLRGLVKTNTEYS	.NRTFVYEVVEGLR	
Acaryochloris_marina	.....	.....	.....
Thermosynechococcus_elongatus	.....MYN.....	..ATNSR.SRMFRYEVVGLR	
Synechocystis_sp.	.....MYS PGYVATSSRQSDAGNRLFVYEVIGLS		
Synechococcus_sp.	.....MYGITSTANSTGNQSYANRLF IYEVVGLG		
Cyanothece_sp.	.....MYSPSLVANS GGSNNNDNRLFVYEVVGLA		
Microcystis_aeruginosa	.....MYS PSTLAG.....	..NRLFVYEVVAGLN	
Crocospaera_watsonii	.....MYSSALGATSGQTTAYGSRMFVYEVVGLS		
Paulinella_chromatophora	.....MRVTTASYRQSDTRTFTLVVVGLS		
Prochlorococcus_marinus	.....MAFNQTEVV LGGIAHIPLV		
Capsicum_annuum	.....	..MATAVTA AVS	
Nicotiana_tobaccum	.....	..MATAVSA AVS	
Pisum_sativum	.....	..MAAAVTA AVS	
Arabidopsis_thaliana	.....	..MSAAISA AVS	
Spinacia_oleracea	.....	.....	
Oryza_sativa	.....	..MAAVNTVSS.	
Triticum_aestivum	.....	..MAAQLTAAL.	
Zea	.....	..MAAVTAA AVS	
Zea_mays	.....	..MATVMAAAV.	
Cyanidium_caldarium	.....	..MFAFLPSVAS	
Cyanophora_paradoxa	.....	..MAFVASVPVF	
consensus			

	40	50	60
Nostoc_commune	QSEETDQTNYP I R K S G S V F I R V P	.....	Y N R M N Q E
Nostoc_punctiforme	QGEETDQTNYP I R K S G S V F I R V P	.....	Y N R M N Q E
Anabaena	.....	.....	.....
Nodularia_spumigena	QNEETDQTNYP I R K S G S V F I R V P	.....	Y N R M N Q E
Arthrospira_platensis	QGQNTDNFNYP I R R S G T V Y L T V P	.....	Y E R M N Q E
Lyngbya_sp.	QGGDSDKFTYP I R R S G R V S I T V P	.....	Y E R M N Q E
Trichodesmium_erythraeum	QSQTAGELNNP I R R S G T V Y I T V P	.....	Y S R M N Q E
Acaryochloris_marina	.....	..MEKP.....	..FDRLK K D
Thermosynechococcus_elongatus	QTAETEKTNYA I R N S G S Q F F N V P	.....	Y D R M N Q F
Synechocystis_sp.	QSTMTDGLDYP I R R S G S T F I T V P	.....	L K R M N Q E
Synechococcus_sp.	GDGRNE..NSLVRKSGTTFITVP	.....	Y A R M N Q E
Cyanothece_sp.	KNGNTDNLNYP V R Q G G S V F I T V P	.....	Y G R M N Q E
Microcystis_aeruginosa	QNDNTDSL D Y S I R Q S G S V F F T V P	.....	Y S R M N Q E
Crocospaera_watsonii	QNTDNDSL D Y P I R R S G S V F I T V P	.....	Y G R M N Q E
Paulinella_chromatophora	IG.....KQRQA EKHF T V P	.....	F S Q L Q A F
Prochlorococcus_marinus	IG.....AFYIVKALFYRG	.....	Q D G E L A P
Capsicum_annuum	..LPSSKSTSF P T R T S I I S P E K	.....	I N F N K V P L
Nicotiana_tobaccum	..LPSSKSTSF S R T S I I S T D K	.....	I N F N K V P L
Pisum_sativum	..LPYSNSTSLP I R T S I V A P E R	.....	L V F K K V S L
Arabidopsis_thaliana	..LPSSKSSSL L T K I S S V S P Q R	.....	I F L K K S T V
Spinacia_oleracea	.....	.....	.....
Oryza_sativa	..LPCKAGAAVAGGAPR.PST..CSVFYPPRCW	.....	.....
Triticum_aestivum	..PSYSPATTKAAAGGSS.PSS..HFLAYPSRPR	.....	.....
Zea	LPSSSSPAAAKAKASASASPSSPCGHLQFPRRHG	.....	.....
Zea_mays	..SSFPS SAVVAKAS PASPCA.....	.....	..APHF R P R
Cyanidium_caldarium	.....YRLQGVH AHG T C S V L G G K	.....	.....
Cyanophora_paradoxa	AN..ASGLKTEAKVCQK P A L K N S	.....	..F F R G E E V
consensus			



	70	80
Nostoc_commune	MRRITRLGGTIVSIQPA	TALQP.....VNGKA
Nostoc_punctiforme	MRRITRLGGTIVSIQP	ITALEP.....VNGKA
Anabaena	.....	.....
Nodularia_spumigena	MRRITRLGGKIVSIQAV	STLEQ.....LNGKV
Arthrospira_platensis	MRRLSKMGAKIVNIYP	PAGETPP.....VRTQA
Lyngbya_sp.	MRRISRLGGRIVNIRPC	NGNPS.....AQSSA
Trichodesmium_erythraeum	MRRITGMGGKILSIKTL	NEHSE.....ANSOK
Acaryochloris_marina	LRNFAKAGAKMVNIDV	PEVEEK.....PIIAE
Thermosynechococcus_elongatus	MQQITRWGGKIVSIQPL	NGTVA.....PLAAT
Synechocystis_sp.	MRRITRMGGKIVSIKPLE	GDSPLPHTEGIAKPSQS
Synechococcus_sp.	MQRITKLGKIVSIRPAED	.....AAQIVS
Cyanothece_sp.	MRRLTRMGAKIVSIKPL	NGEIP.....LQMTA
Microcystis_aeruginosa	MRRITRLGGRIVSIKPF	NGIAP.....VATVS
Crocospaera_watsonii	MRRISRMGGRIVSIQP	VDAETP.....LKSTS
Paulinella_chromatophora	VKLITSRGGKIKAVISS	SDTNP.....
Prochlorococcus_marinus	FSFSYRQAAQRKSSST	TTSTEK.....
Capsicum_annuum	YYRNVSGGSKLVTIRA	QVTTEA.....
Nicotiana_tobaccum	YYRNVSGGSRLVSI	RAQVTTEA.....
Pisum_sativum	NNVSI	SG..RVGTIRAQVTTEA.....
Arabidopsis_thaliana	CYR.....	RVVSVKAQVTTDTT.....
Spinacia_oleracea	.....	.....
Oryza_sativa	SKRSSGNGVRAQASTT	TETTAAPA.....
Triticum_aestivum	NVR...NGVRAQVSTT	EPTEAEP.....
Zea	GPR..AVRLRVQVSTT	TET...AE.....
Zea_mays	AVR...AAIRAQASAVE	AP.....
Cyanidium_caldarium	.....	ELRLLPSRVGCR.....
Cyanophora_paradoxa	TSR...SFFASQAVSA	KPATTFE.....
consensus	.....	.....

	90	100	110	120
Nostoc_commune	SLGNATSEVSE	LATSGETANT	EGNGKATPVN....	
Nostoc_punctiforme	SFGNATSVVSE	LAKSGETAN	SEGNGKATPVN....	
Anabaena	.....	.....	.....	
Nodularia_spumigena	SHESAEHKEESL	VTSDKAA	NTGNGKATPVANSEV	
Arthrospira_platensis	APENGOQSSQSS	GTQTP.....		
Lyngbya_sp.	TSGNGLQSSQSS	GEQKK.....		
Trichodesmium_erythraeum	T....KTKQKTK	PMTE.....		
Acaryochloris_marina	P....APEAPV	APPQ.....		
Thermosynechococcus_elongatus	T.....EPA	ANNNG.....		
Synechocystis_sp.	EGSGSEAVAN	PAPESNKT.....		
Synechococcus_sp.	EGQSSAQASA	QSPMASST.....		
Cyanothece_sp.	S....OPTQ	QATKETEK	KGK.....	
Microcystis_aeruginosa	SASTPQPIA	QSSPVPEQTK.....		
Crocospaera_watsonii	NGSSTAKVA	QP.QASNQTE.....		
Paulinella_chromatophora	.....RSES	IIRIPA.....		
Prochlorococcus_marinus	.....PD	.....		
Capsicum_annuum	.....	.....		
Nicotiana_tobaccum	.....	.....		
Pisum_sativum	.....	.....		
Arabidopsis_thaliana	.....	.....		
Spinacia_oleracea	.....	.....		
Oryza_sativa	.....	.....		
Triticum_aestivum	.....	.....		
Zea	.....	.....		
Zea_mays	.....	.....		
Cyanidium_caldarium	.....	.....		
Cyanophora_paradoxa	.....	.....		
consensus	.....	.....		

	130	140
Nostoc_commune	....AHSAAEQNK..DKKGNTMTQAKAKKDHGDVP	
Nostoc_punctiforme	....AHSAAEQNK..DKKGNTMTQAKAKKDHGDVP	
Anabaena	.....TQAKAK..HADVP	
Nodularia_spumigena	KGFAKPPAEDQLKKKDKKGNTMTQAKAKK..GADV	
Arthrospira_platensis	.....TMTQAKAKT...DIP	
Lyngbya_sp.	.....PMTQAKAHT...DVP	
Trichodesmium_erythraeum	.....AKPRRSEKK...SVP	
Acaryochloris_marina	.....SAKKAKKKD...DIP	
Thermosynechococcus_elongatus	.....AAPVKEKKV...DIP	
Synechocystis_sp.	.....MTTTPKEKKADDIP	
Synechococcus_sp.	.....KIVHPKTTDTS..VP	
Cyanothece_sp.	.....SMTQAKAKAKGDIP	
Microcystis_aeruginosa	.....KKAMTQAKEKTDIP	
Crocospaera_watsonii	.....KKRKSMTQAKTKIP	
Paulinella_chromatophora	.....TVTTSPAKPAHHDVP	
Prochlorococcus_marinus	.....TKSP..PAQTAIP	
Capsicum_annuum	.....PAKVEKISKKQDEGVV	
Nicotiana_tobaccum	.....PAKVEKISKKQDEGVI	
Pisum_sativum	.....PAKVVKHSHKQDENIV	
Arabidopsis_thaliana	.....EAPPVKKVVKESKKQEEGIV	
Spinacia_oleracea	.....	
Oryza_sativa	.....AEVTTKVEKVSKKQVDGVV	
Triticum_aestivum	.....PAAPAKPVKISKKQDEGVV	
Zea	.....AEPVKKLEKVSKKQEEGLV	
Zea_mays	.....ATAKAKKESKKQEEGVV	
Cyanidium_caldarium	.....RGSATLHMVAEEKVVP	
Cyanophora_paradoxa	.....VDTTIRAQAVDAKKKGDIP	
consensus		

	150	160	170	180
Nostoc_commune	VNTYRPNAPF	IGKVISNEPLVKEGGIGIVQHLKFD		
Nostoc_punctiforme	VNTYRPNAPF	IGKVISNEPLVKEGGIGIVQHLKFD		
Anabaena	VNLYRPNAPF	IGKVISNEPLVKEGGIGIVQHLKFD		
Nodularia_spumigena	VNIYRPNAPFV	GKVISNEPLVKEDGIGIVQHLKFD		
Arthrospira_platensis	VNIYKPKNPY	IGKCLSNEELVREGGTGTVRHLIFD		
Lyngbya_sp.	INIYKPKTPFT	GKCLSSKELVQEGGEGTVRHLTFD		
Trichodesmium_erythraeum	VNTYRPNPFI	GKCLSTAELVNEGGETVRHLVFD		
Acaryochloris_marina	VNIYRPNPFI	GKCLSTAELVREGGEGTVRHLVFD		
Thermosynechococcus_elongatus	VNIYRPNNPC	IGKVISNEELVREGGEGTVKHIIFD		
Synechocystis_sp.	VNIYRPNPFI	IGKCLSTAELVREGGEGTVRHLVFD		
Synechococcus_sp.	VNIYRPNPFI	IGKCLSTAELVREGGEGTVRHLVFD		
Cyanothece_sp.	VNIYRPNPFI	IGKCLSTAELVREGGEGTVRHLVFD		
Microcystis_aeruginosa	VNIYRPNPFI	IGKCLSTAELVREGGEGTVRHLVFD		
Crocospaera_watsonii	TNIYRQKSPY	VGKCIENYALVAEGGSGIVQHVTFD		
Paulinella_chromatophora	VNLYKPKDPF	VSTVIDNYSLLSPGAIGRVNHITFD		
Prochlorococcus_marinus	INLYKPKAPF	EGTVLENYSLVKEGAVGRVNHITFD		
Capsicum_annuum	VNKFRPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Nicotiana_tobaccum	VNKFRPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Pisum_sativum	VNKFRPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Arabidopsis_thaliana	VNKFRPKNPY	TGRCLLNTKITGDDAPGETTWHIVFT		
Spinacia_oleracea	.....			
Oryza_sativa	TNKYRPKEPY	TGRCLLNTKITGDDAPGETTWHMVFS		
Triticum_aestivum	TNKYRPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Zea	TNKYRPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Zea_mays	TNLYKPKEPY	VGRCLLNTKITGDDAPGETTWHMVFS		
Cyanidium_caldarium	VNLFRPSSPL	VGTTCIYNKKIVGDDAPGDTCHVIIH		
Cyanophora_paradoxa	VNLFRPANPY	IGKCIYNERIVGEGAPGETKHIIFT		
consensus				

	190	200	210
Nostoc_commune	LSGSN..LKYI	EGQSIGIIPP	GLDKN GKPEKLRLY
Nostoc_punctiforme	LSGGD..LKYI	EGQSIGIIPP	GLDKN GKPEKLRLY
Anabaena	LTGGN..LKYI	EGQSIGIIPP	GVDKN GKPEKLRLY
Nodularia_spumigena	LSGGD..LKYV	EGQSIGIIPP	GVDKN GKPEKLRLY
Arthrospira_platensis	ISGGD..LRYL	EGQSIGIIPP	GTDNN GKPHKLRLY
Lyngbya_sp.	LSGGD..LRYL	EGQSIGIIPP	GTDAN GKPHKLRLY
Trichodesmium_erythraeum	LSGSD..LHYL	EGQSIGIIPP	GKDAK GKAHKLRLY
Acaryochloris_marina	LSEGD..LRYI	EGQSIGIIPA	GTDAN GKPHKLRLY
Thermosynechococcus_elongatus	ISGTE..LRYL	EGQSIGIIPA	GTDAN GKPHKLRLY
Synechocystis_sp.	LSAGD..LRYL	EGQSIGIIPP	GEDDK GKPHKLRLY
Synechococcus_sp.	ISEGD..LRYL	EGQSIGIIPP	GEDKN GKPHKLRLY
Cyanothece_sp.	LSGGD..LHYV	EGQSIGIIPP	GTD DK GKPHKLRLY
Microcystis_aeruginosa	LSGSD..LRYL	EGQSIGIIPP	GTDAN GKPHKLRLY
Crocospaera_watsonii	ISGGD..LHYL	EGQSLAIIPP	GTD AK GKPHKSRLY
Paulinella_chromatophora	LSGGN..LRYV	EGQSIGIIPD	GTDVN GKPHKLRLY
Prochlorococcus_marinus	LAGSDPHLSYV	EGQSIGIIPA	GTDAN GKPHKLRLY
Capsicum_annuum	TEGEIP...YR	EGQSIGVIAD	GVDAN GKPHKLRLY
Nicotiana_tobaccum	TEGEVP...YR	EGQSIGVIAD	GVDAN GKPHKLRLY
Pisum_sativum	TEGEVP...YR	EGQSIGVDPD	GIDKN GKPHKLRLY
Arabidopsis_thaliana	TEGEVP...YR	EGQSIGVPE	GIDKN GKPHKLRLY
Spinacia_oleracea	.....R	EGQSVGVIPD	GEDKN GKPHKLRLY
Oryza_sativa	TDGEIP...YR	EGQSIGVIPD	GIDKN GKPHKLRLY
Triticum_aestivum	TEGEVP...YR	EGQSIGVIAD	GEDKN GKPHKLRLY
Zea	TEGEVP...YR	EGQSIGVIAD	GEDKN GKPHKLRLY
Zea_mays	TEGKIP...YR	EGQSIGVIAD	GVDKN GKPHKLRLY
Cyanidium_caldarium	HDGKLP...YL	EGQSVGIPE	GTD DK GRPHKLRLY
Cyanophora_paradoxa	HEGKVP...YL	EGQSIGIIPP	GTD KD GKPHKLRLY
consensus		* * * *	* * * * *

	220	230	240	250
Nostoc_commune	SIAS	TRHGDDVDDKTIVSL	CVRQLEYKHPETSETVY	
Nostoc_punctiforme	SIAS	TRHGDDVDDKTIVSL	CVRQLEYKHPETGETVY	
Anabaena	SIAS	TRHGDDVDDKTIVSL	CVRQLEYKHPESGETVY	
Nodularia_spumigena	SIAS	TRHGDDVDDKTIVSL	CVRQLEYKHPETGETVY	
Arthrospira_platensis	SIAS	TRHGDDVDDKTIVSL	CVRQLEYKHPETGETVY	
Lyngbya_sp.	SIAS	TRHGDDNLDEKTIVSL	CVRQLEYKHPETGDTVY	
Trichodesmium_erythraeum	SIAS	TRHGDDHLNDQTVSL	CVRRLEYNHPETGERIY	
Acaryochloris_marina	SIAS	TRHGDDRVDDKTIVSL	CVRQLEYDHPETGERVY	
Thermosynechococcus_elongatus	SIAS	TRHGDDFQDDKTIVSL	CVRRLEYKDKETGETIY	
Synechocystis_sp.	SIAS	TRHGDDDFGDDKTIVSL	CVRQLEYQN.EAGETVQ	
Synechococcus_sp.	SIAS	TRHGDDMEDNKTIVSL	CVRQLEYQDPESGETVY	
Cyanothece_sp.	SIAS	TRHGDDKKDDKTIVSL	CVRQLEYEHPETKETVY	
Microcystis_aeruginosa	SIAS	TRHGDDKLDKKTIVSL	CVRQLEYQHPETKETVY	
Crocospaera_watsonii	SIAS	TRHGDDKVDDKTIVSL	CVRQLEYEHPETKETVY	
Paulinella_chromatophora	SIAS	SRHGDDNLQGNITIVSL	CVRQLQYEK..DGETIN	
Prochlorococcus_marinus	SIAS	TRHGDDNLEGGKTIVSL	CVRQLQYEL..DGKTID	
Capsicum_annuum	SIAS	SALGDDFGDSKTIVSL	CVKRLVYTN.DKGEEVK	
Nicotiana_tobaccum	STAS	SALGDDFGDSKTIVSL	CVKRLVYTN.DKGEEVK	
Pisum_sativum	SIAS	SAIGDDFGDSKTIVSL	CVKRLVYTN.DAGEVVK	
Arabidopsis_thaliana	SIAS	SAIGDDFGDSKTIVSL	CVKRLVYTN.DGGEIVK	
Spinacia_oleracea	SIAS	SALGDDFGDAKSVSL	CVKRLIYTN.DAGETIK	
Oryza_sativa	SIAS	SAIGDDFADSKTIVSL	CVKRLVYTN.DQGEIVK	
Triticum_aestivum	SIAS	SALGDDFGDSKTIVSL	CVKRLVYTN.DAGEVVK	
Zea	SIAS	SALGDDFGDSKTIVSL	CVKRLVYTN.DQGEVVK	
Zea_mays	SIAS	SAIGDDFGDSKTIVSL	CVKRLIYTN.DAGEIVK	
Cyanidium_caldarium	SIAS	TAAAGDDFGDYKTL	SLVVKRLVYTN.EKGEEVR	
Cyanophora_paradoxa	SIAS	TRHGDDFGDDKTIVSL	SVKRLVYTD.ANGNLVK	
consensus	* * *	* * *	* * *	* * *

	260	270	280
Nostoc_commune	GVCSTHLCFLKPG	.EEVKIT	GPVKGEMLLPNDPDA
Nostoc_punctiforme	GVCSTHLCFLKPG	.EEVKIT	GPVKGEMLLPNDPDA
Anabaena	GVCSTYLTHTIEPG	.SEVKIT	GPVKGEMLLPDDPEA
Nodularia_spumigena	GVCSTHLTQLEVG	.AEVKIT	GPVKGEMLLPEDPEA
Arthrospira_platensis	GVCSTYLCNLEAG	.ADVAIT	GPVKGEMLLPEDEDA
Lyngbya_sp.	GVCSTYLCNIKEG	.DDVSI	GPVKGEMLLPDDEDA
Trichodesmium_erythraeum	GVCSSYLCGMEEG	.ADVAIT	GPVKGEMLLPDDEDA
Acaryochloris_marina	GVCSTHLCDMQPG	.DDVKIT	GPVKGEMLLPDDPEA
Thermosynechococcus_elongatus	GVCSSYLNQLQPG	.DEVKIT	GPVKGEMLLSDDPEA
Synechocystis_sp.	GVCSTYLCNIKEG	.DDIAIT	GPVKGEMLLPDDEDA
Synechococcus_sp.	GVCSTYLCNLPVGT	DDVKIT	GPVKGEMLLPDDEDA
Cyanothece_sp.	GVCSTYLCNLEVG	.ADVAIT	GPVKGEMLLPEDEDA
Microcystis_aeruginosa	GVCSTYLCNVEVG	.ADVAIT	GPVKGEMLLPDDEDA
Crocospaera_watsonii	GVCSTYLCNLEVG	.ADVAMW	GPVKGEMLLPDEEDA
Paulinella_chromatophora	GVCSTFLCDIKPG	.AKTKMT	GPVKGEMLLPADEMA
Prochlorococcus_marinus	GVCSTYLCDIKPG	.AKTKIT	GPVKGEMLLPDDDEEA
Capsicum_annuum	GVCSTNFLCDLKP	G.ADVKIT	GPVKGEMLLMPKDPNA
Nicotiana_tobaccum	GVCSTNFLCDLKP	G.AEVKIT	GPVKGEMLLMPKDPNA
Pisum_sativum	GVCSTNFLCDLKP	G.SEVKIT	GPVKGEMLLMPKDPNA
Arabidopsis_thaliana	GVCSTNFLCDLKP	G.DEAKIT	GPVKGEMLLMPKDPNA
Spinacia_oleracea	GVCSTNFLCDLKP	G.AEVKLT	GPVKGEMLLMPKDPNA
Oryza_sativa	GVCSTNFLCDLKP	G.SDVKIT	GPVKGEMLLMPKDPNA
Triticum_aestivum	GVCSTNFLCDLKP	G.SEVKIT	GPVKGEMLLMPKDPNA
Zea	GVCSTNFLCDLKP	G.AEVKIT	GPVKGEMLLMPKDPNA
Zea_mays	GVCSTNFLCDLQP	G.DNVQIT	GPVKGEMLLMPKDPNA
Cyanidium_caldarium	GVCSTNFLNDIKPG	G.EPIKMT	GPVKGEMLLMPDDPNA
Cyanophora_paradoxa	GVCSTNYLCDLKP	G.DEVMIT	GPVGTMLMPEDQSA
consensus	**** *	*	**** ** *

	290	300	310	320
Nostoc_commune	NVIMMATA	TGTGIAPM	RAYLWRQF	FKDAERAANPEYQF
Nostoc_punctiforme	NVIMMATA	TGTGIAPM	RAYLWRQF	FKDAERAANPEYQF
Anabaena	NVIMMLA	TGTGIAPM	RTYLWRMF	FKDAERAANPEYQF
Nodularia_spumigena	KVIMMATA	TGTGIAPM	RAYLWRMF	FKDAERAANPEYQF
Arthrospira_platensis	TIIMMATA	TGTGIAPF	RAFLWRI	FK...EQHEDYKF
Lyngbya_sp.	TIIMMATA	TGTGIAPF	RAFIWRMF	FKE..REQNPDYQF
Trichodesmium_erythraeum	TIIMMLA	TGTGIAPY	RAFLWRMF	FKE..REQNPDYQF
Acaryochloris_marina	NIIMMG	TGTGIAPF	RAYLWRMF	FK...EKHDDYKF
Thermosynechococcus_elongatus	TIIMMLA	TGTGIAPF	RAFLWRMF	FK...ENNPDYQF
Synechocystis_sp.	NIVMLA	TGTGIAPF	RAFLWRMF	FK...EQHEDYKF
Synechococcus_sp.	TVVMLA	TGTGIAPF	RAFLWRMF	FK...EQHEDYKF
Cyanothece_sp.	NIIMMLA	TGTGIAPF	RAFLWRMF	FK...EQHEDYKF
Microcystis_aeruginosa	TIIMMATA	TGTGIAPF	RAFLWRMF	FK...EQHEDYKF
Crocospaera_watsonii	NIIMMLA	TGTGIAPF	RSFLWRMF	FF...ENNPEYKF
Paulinella_chromatophora	NVIMMLA	TGTGIAPM	RTYLRRMF	FEPGERSKNPEYQF
Prochlorococcus_marinus	NVIMMLA	TGTGIAPM	RAYLRRMF	FEPTEERSKN.GWKF
Capsicum_annuum	TVIMLG	TGTGIAPF	RSFLWKMF	FF...EKHDDYKF
Nicotiana_tobaccum	TVIMMLA	TGTGIAPF	RSFLWKMF	FF...EKHEDYKF
Pisum_sativum	TVIMMLG	TGTGIAPF	RSFLWKMF	FF...EKHEDYQF
Arabidopsis_thaliana	TIIMMLG	TGTGIAPF	RSFLWKMF	FF...EEHEDYKF
Spinacia_oleracea	TIIMMLG	TGTGIAPF	RSFLWKMF	FF...EKHDDYKF
Oryza_sativa	TIIMMLG	TGTGIAPF	RSFLWKMF	FF...EEHDDYKF
Triticum_aestivum	TIIMMLA	TGTGIAPF	RSFLWKMF	FF...EEHEDYKF
Zea	TIIMMLA	TGTGIAPF	RSFLWKMF	FF...EEHEDYKY
Zea_mays	TIIMMLA	TGTGIAPF	RSFLWKMF	FF...EKHDDYKF
Cyanidium_caldarium	TIIMMLA	TGTGIAPF	RAFMRKA	FV...EKHADYQF
Cyanophora_paradoxa	TIIMMLA	TGTGIAPF	RSFLRRMF	FE...ETHADYKF
consensus	*	*****	*	*

Nostoc\_commune  
 Nostoc\_punctiforme  
 Anabaena  
 Nodularia\_spumigena  
 Arthrospira\_platensis  
 Lyngbya\_sp.  
 Trichodesmium\_erythraeum  
 Acaryochloris\_marina  
 Thermosynechococcus\_elongatus  
 Synechocystis\_sp.  
 Synechococcus\_sp.  
 Cyanothece\_sp.  
 Microcystis\_aeruginosa  
 Crocosphaera\_watsonii  
 Paulinella\_chromatophora  
 Prochlorococcus\_marinus  
 Capsicum\_annuum  
 Nicotiana\_tobaccum  
 Pisum\_sativum  
 Arabidopsis\_thaliana  
 Spinacia\_oleracea  
 Oryza\_sativa  
 Triticum\_aestivum  
 Zea  
 Zea\_mays  
 Cyanidium\_caldarium  
 Cyanophora\_paradoxa  
 consensus

330 340 350  
 KGF<sup>b</sup>SWLIFGVP TTPNL<sup>b</sup>LY<sup>b</sup>KEELEEEIQOKYPDNFRL  
 KGF<sup>b</sup>SWLIFGVP TTPNL<sup>b</sup>LY<sup>b</sup>KEELEEEIQOKYPENFRL  
 KGF<sup>b</sup>SWL<sup>b</sup>VF<sup>b</sup>GVP TTPNI<sup>b</sup>LY<sup>b</sup>KEELEEEIQOKYPDNFRL  
 KGF<sup>b</sup>SWLIFGVP TTPNI<sup>b</sup>LY<sup>b</sup>KEELEEQMQEKYPDNFRL  
 KGLAWL<sup>b</sup>FFG<sup>b</sup>GIPYSPNI<sup>b</sup>LY<sup>b</sup>QEELEELQQQFPENFRL  
 KGLAWL<sup>b</sup>FFG<sup>b</sup>CAYTPNI<sup>b</sup>LY<sup>b</sup>KEELEELQRQFPDNFRV  
 KGLAWL<sup>b</sup>FFG<sup>b</sup>CPYTPNI<sup>b</sup>LY<sup>b</sup>KEELEELQREFPDNFRL  
 KGLAWL<sup>b</sup>FFG<sup>b</sup>GVAYTPNI<sup>b</sup>LY<sup>b</sup>KEELEELQSQYPDNFRL  
 KGLAWL<sup>b</sup>FFG<sup>b</sup>GVAYTANI<sup>b</sup>LY<sup>b</sup>KDELEAIIQAQYDPDFRL  
 KGLAWLIFGIPKSENI<sup>b</sup>LY<sup>b</sup>KDDLEKMAAEFPDNFRL  
 KGKAWLIFGVPYTANI<sup>b</sup>LY<sup>b</sup>KDDFEKMAAENPDNFRL  
 KGLAWLIFGVPYSANI<sup>b</sup>LY<sup>b</sup>KEDLEEIEKTYPDNFRL  
 KGLAWLIFGVPKTANI<sup>b</sup>LY<sup>b</sup>QEELEKIAAEFPDNFRL  
 KGKSWLIFGVPYSANV<sup>b</sup>LY<sup>b</sup>KDQLEEIQTKYPDNFDL  
 RGKAWL<sup>b</sup>FMG<sup>b</sup>GAPTTANL<sup>b</sup>LY<sup>b</sup>DDDFNRYQSEFPENFRY  
 RGKAWL<sup>b</sup>FMG<sup>b</sup>GAPYTANL<sup>b</sup>LY<sup>b</sup>DEDFERYLREFPDNFYI  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFEKMKEKAPENFRL  
 NGTAWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFEKMKEKAPENFRL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFEKMKEKAPEXFRL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFEKMKEKNPDNFRL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFEKMKEKAPDNFRL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSTL<sup>b</sup>LY<sup>b</sup>REEFERMKEIAPERFRL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSTL<sup>b</sup>LY<sup>b</sup>KEEFEKMKVEIGGENFRL  
 TGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSTL<sup>b</sup>LY<sup>b</sup>KEELEKMKEMAPDNFRL  
 NGLGWL<sup>b</sup>FLG<sup>b</sup>VPTSSSL<sup>b</sup>LY<sup>b</sup>KEEFGKMKERAPENFRV  
 KGKML<sup>b</sup>LYL<sup>b</sup>GVPTSSSL<sup>b</sup>LY<sup>b</sup>RDELEEMKANFPDQVEL  
 NGLAWL<sup>b</sup>FLG<sup>b</sup>VPTSSTL<sup>b</sup>LY<sup>b</sup>REELEKMQKANPNNFRL  
 \* \* \* \*\*

Nostoc\_commune  
 Nostoc\_punctiforme  
 Anabaena  
 Nodularia\_spumigena  
 Arthrospira\_platensis  
 Lyngbya\_sp.  
 Trichodesmium\_erythraeum  
 Acaryochloris\_marina  
 Thermosynechococcus\_elongatus  
 Synechocystis\_sp.  
 Synechococcus\_sp.  
 Cyanothece\_sp.  
 Microcystis\_aeruginosa  
 Crocosphaera\_watsonii  
 Paulinella\_chromatophora  
 Prochlorococcus\_marinus  
 Capsicum\_annuum  
 Nicotiana\_tobaccum  
 Pisum\_sativum  
 Arabidopsis\_thaliana  
 Spinacia\_oleracea  
 Oryza\_sativa  
 Triticum\_aestivum  
 Zea  
 Zea\_mays  
 Cyanidium\_caldarium  
 Cyanophora\_paradoxa  
 consensus

360 370 380 390  
 TAAI<sup>b</sup>SRE<sup>b</sup>QKNPQ<sup>b</sup>GGRMY<sup>b</sup>IQDRVAEHADELWQLIKN  
 TAAI<sup>b</sup>SRE<sup>b</sup>QKNPQ<sup>b</sup>GGRMY<sup>b</sup>IQDRVAEHADELWQLIKN  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKNPQ<sup>b</sup>GGRMY<sup>b</sup>IQDRVAEHADQLWQLIKN  
 TCAI<sup>b</sup>SRE<sup>b</sup>QKNPQ<sup>b</sup>GGRMY<sup>b</sup>IQDRVAEHADELWQLIKE  
 TLAI<sup>b</sup>SRE<sup>b</sup>QQNPB<sup>b</sup>GKMY<sup>b</sup>IQDRIKENADQLWELIQK  
 TYAV<sup>b</sup>SRE<sup>b</sup>QKNKD<sup>b</sup>GKMY<sup>b</sup>IQHRIQENADELWQLNQK  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKNKD<sup>b</sup>GKMY<sup>b</sup>IQHRIQENAEELWQLIQK  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKAAD<sup>b</sup>GSKMY<sup>b</sup>IQSRIAEHADELWELVQK  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKTPD<sup>b</sup>GKMY<sup>b</sup>IQGRIAEHADEIWQLLQK  
 TYAI<sup>b</sup>SRE<sup>b</sup>QQNAB<sup>b</sup>GGRMY<sup>b</sup>IQHRVAENAEELWNLMQN  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKTAD<sup>b</sup>GKVVY<sup>b</sup>VQSRVSEYADELFEMIQK  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKNAB<sup>b</sup>GGRMY<sup>b</sup>IQHRVGEYAEELWKLQMN  
 TYAI<sup>b</sup>SRE<sup>b</sup>QQNPQ<sup>b</sup>GGRMY<sup>b</sup>IQHRVAEHADEIWNLLQS  
 TYAI<sup>b</sup>SRE<sup>b</sup>QKNSE<sup>b</sup>GGRMY<sup>b</sup>IQHRVAEQAEKLWTMLQD  
 TKAI<sup>b</sup>SRE<sup>b</sup>QQNTS<sup>b</sup>GGRMY<sup>b</sup>IQDRVTEHADEIFGMIED  
 TKAI<sup>b</sup>SRE<sup>b</sup>QQNPQ<sup>b</sup>GGRMY<sup>b</sup>IQDRVMEYADQIFKMIEN  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNEK<sup>b</sup>GKMY<sup>b</sup>IQTRMAQYAEELWTLTKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNEK<sup>b</sup>GKMY<sup>b</sup>IQTRMAQYAEELWTLTKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QVXDK<sup>b</sup>GEXMY<sup>b</sup>IXTRMAQYAXELWELLKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNEK<sup>b</sup>GKMY<sup>b</sup>IQTRMAEYAEELWELLKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNEK<sup>b</sup>GKMY<sup>b</sup>IQTRMAQYAVELWEMLKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNAAG<sup>b</sup>GKMY<sup>b</sup>IQTRMAEYKDELWELLKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNAAG<sup>b</sup>GKMY<sup>b</sup>IQTRMAEYKEELWEMLKK  
 DF<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNAAG<sup>b</sup>GKMY<sup>b</sup>IQTRMAEYKEELWELLKK  
 DY<sup>b</sup>AV<sup>b</sup>SRE<sup>b</sup>QTNAAG<sup>b</sup>GERMY<sup>b</sup>IQTRMAEYKEELWELLKK  
 HYAI<sup>b</sup>SRE<sup>b</sup>MKNKQ<sup>b</sup>GGRMY<sup>b</sup>LQDSMAERGEIWIQLLRK  
 DYAI<sup>b</sup>SRE<sup>b</sup>QTD<sup>b</sup>SK<sup>b</sup>GKMY<sup>b</sup>IQNRIAEYANEFWNMIQK  
 \* \* \* \* \*



	400	410	420
Nostoc_commune	EKTHT	YICGLR	GMEEGIDAALTA
Nostoc_punctiforme	EKTHT	YICGLR	GMEEGIDAALTA
Anabaena	QKTHY	YICGLR	GMEEGIDAALS
Nodularia_spumigena	EKTHT	YICGLR	GMEEGIDEALTA
Arthrospira_platensis	PNTHT	YICGLK	GMEEGIDEGMS
Lyngbya_sp.	PNTHT	YICGLK	GMEEGIDEGMS
Trichodesmium_erythraeum	PNAHT	YICGLK	GMEDGIDEGMS
Acaryochloris_marina	ENTHT	YICGLK	GMEEGIDEGMS
Thermosynechococcus_elongatus	KNTHV	YMCGLR	GMEPGIDEAMT
Synechocystis_sp.	PKTHT	YMCGLK	GMEPGIDEAFTA
Synechococcus_sp.	PNTHT	YMCGLK	GMOPPIDETFTA
Cyanothece_sp.	PKTHT	YMCGLK	GMEDGIDQALGA
Microcystis_aeruginosa	PKTHA	YMCGLK	GMEDGIDDAISG
Crocospaera_watsonii	PKTHL	YMCGLK	GMESGLEEGLRD
Paulinella_chromatophora	SRTHV	YMCGLR	GMEPGIDQAMT
Prochlorococcus_marinus	PKTHV	YMCGLK	GMEPGIDEAMT
Capsicum_annuum	DNTFV	YMCGLK	GMEOGIDDIMSS
Nicotiana_tobaccum	DNTFI	YMCGLK	GMEOGIDEIMSA
Pisum_sativum	DXTFV	YMCGLK	GMKEGIDIMVSL
Arabidopsis_thaliana	DNTFV	YMCGLK	GMKEGIDIMVSL
Spinacia_oleracea	DNTYV	YMCGLK	GMKEGIDIMVSL
Oryza_sativa	DNTYV	YMCGLK	GMKEGIDIMIDL
Triticum_aestivum	DNTYV	YMCGLK	GMKEGIDIMVDL
Zea	DNTYV	YMCGLK	GMKEGIDIMLDL
Zea_mays	DNTYV	YMCGLK	GMKEGIDIMVSL
Cyanidium_caldarium	DNTYV	YMCGLK	GMDSGIDSFMTD
Cyanophora_paradoxa	PNTFV	YMCGLR	GMEDGIQQCMEDI
consensus		* * * *	*

	430	440
Nostoc_commune	QK.ELK	KKAGRWHVET
Nostoc_punctiforme	QK.QLK	KKAGRWHVET
Anabaena	QK.DLK	KKAGRWHVET
Nodularia_spumigena	QK.QLK	KAHRWHVET
Arthrospira_platensis	QK.QLK	KKHRWHVET
Lyngbya_sp.	QK.QLK	KDHRWHVET
Trichodesmium_erythraeum	QK.KLK	KEGRWHVET
Acaryochloris_marina	QR.TLK	KAHRWHVET
Thermosynechococcus_elongatus	LKGT	LKKEGRWHVET
Synechocystis_sp.	QR.EMK	KEHRWHVET
Synechococcus_sp.	RR.SM	KKEHRWHVEV
Cyanothece_sp.	QK.QM	KKEHRWHVET
Microcystis_aeruginosa	QK.QLK	KEHRWHVET
Crocospaera_watsonii	VK.QLK	KEHRWHVEV
Paulinella_chromatophora	RP.QLK	KAERWHVET
Prochlorococcus_marinus	RP.QLK	KAHRWHVET
Capsicum_annuum	KK.QLK	KAEQWNV
Nicotiana_tobaccum	KK.QLK	KAEQWNV
Pisum_sativum	KR.TLK	KAEQWNV
Arabidopsis_thaliana	KK.QLK	KRSEQWNV
Spinacia_oleracea	KR.QLK	KAEQWNV
Oryza_sativa	KK.QLK	KSEQWNV
Triticum_aestivum	KK.QLK	KAEQWNV
Zea	KK.QLK	KSEQWNV
Zea_mays	KK.QLK	RGDQWNV
Cyanidium_caldarium	KK.QLK	QQHRYNV
Cyanophora_paradoxa	VK.GLK	KEKRWHVET
consensus	*	* * *

## Calculation of Standard Apparent Hydride Transfer Energy

The calculation of the apparent redox potentials of NADP and FAD is done as described in CRC Handbook of Chemistry and Physics, David R. Lide Ed., 85th edition, 2004-2005, page 7-9, "Standard Transformed Gibbs Energy of Formation For Important Biochemical Species" by Petr Vanysek.

$$E'^{\circ} = -\frac{1}{nF} \left( \Delta_f G'^{\circ}(\text{red}) - \Delta_f G'^{\circ}(\text{ox}) \right)$$

with  $n = 2$  for two electron reductions and  $F = 9.6485 \cdot 10^4 \text{Cmol}^{-1}$ . For  $I = 100 \text{ mM}$ ,  $\text{pH} 7.0$ ,  $298.15 \text{ K}$  and  $100 \text{ kPa}$  the values of  $1255.17 \text{ kJ/mol}$  (FAD ox),  $1297.43 \text{ kJ/mol}$  (FAD red),  $1008.7 \text{ kJ/mol}$  (NADP ox) and  $1070.97 \text{ kJ/mol}$  (NADP red) are given. Using the above equation, standard apparent reduction potentials of  $E'^{\circ}(\text{FAD}) = -219.00 \text{ mV}$  and  $E'^{\circ}(\text{NADP}) = -322.69 \text{ mV}$  can be obtained. Thus, the hydride transfer from FAD to NADP in aqueous solution is  $\Delta E'^{\circ} = 104 \text{ mV}$  which corresponds to an energy of  $2.4 \text{ kcal/mol}$ .