A dynamic interaction process between KaiA and KaiC is critical to the cyanobacterial circadian oscillator

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Supplementary Text S1. The analysis of the KaiA-KaiC binding equilibrium

In this section we will prove that K_{Dfit}, which is the apparent value of the real equilibrium constants of two steps of the KaiA-KaiC binding processes, should be smaller than the apparent values corresponding to K_{Dapp1} and K_{Dapp2} in the following part. For simplicity, A stands for KaiA, and C stands for KaiC (C1 and C2 are two different conformational statuses).

$$A + C \underset{kd_1}{\overset{ka_1}{\rightleftarrows}} AC_1 \underset{k_1}{\overset{k_2}{\rightleftarrows}} AC_2 \underset{ka_2}{\overset{kd_2}{\rightleftarrows}} A + C$$

According to the binding processes shown above and the mass action principle, we obtain that:

$$\frac{d[AC_1]}{dt} = ka_1[A][C] - kd_1[AC_1] + k_1[AC_2] - k_2[AC_1] \quad (1)$$

$$\frac{d[AC_2]}{dt} = ka_2[A][C] - kd_2[AC_1] + k_2[AC_1] - k_1[AC_2] \quad (2)$$

Moreover, we suppose that all steps above are rapid and pre-equilibrium processes compared to the phosphorylation processes. Thus, we have

$$\frac{d[AC_1]}{dt} = ka_1[A][C] - kd_1[AC_1] + k_1[AC_2] - k_2[AC_1] = 0 \quad (3)$$

$$\frac{d[AC_2]}{dt} = ka_2[A][C] - kd_2[AC_2] + k_2[AC_1] - k_1[AC_2] = 0 \quad (4)$$

Combining (3) with (4), we may conclude that

$$(ka_1 + ka_2)[A][C] = kd_1[AC_1] + kd_2[AC_2] \quad (5)$$

Suppose that $[AC_{\mathrm{tot}}]$ is the total concentration of complex AC, i.e.

$$[AC_{\mathrm{tot}}] = [AC_1] + [AC_2] \quad (6)$$

Thus, there is a number γ $(0 < \gamma < 1)$ such that

$$[AC_1] = \gamma[AC_{\mathrm{tot}}] \quad (7)$$

Combining (5), (6), and (7), we have

$$(ka_1 + ka_2)[A][C] = (\gamma kd_1 + (1-\gamma)kd_2)[AC_{\mathrm{tot}}] \quad (8)$$

$$(ka_1 + ka_2)[A][C] = \left(kd_1 + \frac{(1-\gamma)}{\gamma}kd_2\right)[AC_1] \quad (9)$$

$$(ka_1 + ka_2)[A][C] = \left(\frac{\gamma}{(1-\gamma)}kd_1 + kd_2\right)[AC_2] \quad (10)$$

Denoting K_{Dapp1} = [A][C]/[AC_1], K_{Dapp2} = [A][C]/[AC_2], and from (8), (9), (10), we obtain

$$K_{\mathrm{Dfit}} = \frac{[A][C]}{[AC_{\mathrm{tot}}]} = \frac{(\gamma kd_1 + (1-\gamma)kd_2)}{ka_1 + ka_2}, \quad (11)$$

$$K_{Dobs1} = \frac{[A][C]}{[AC_1]} = \frac{(\gamma kd_1 + (1-\gamma)kd_2)}{\gamma(ka_1 + ka_2)}\ , \quad (12)$$

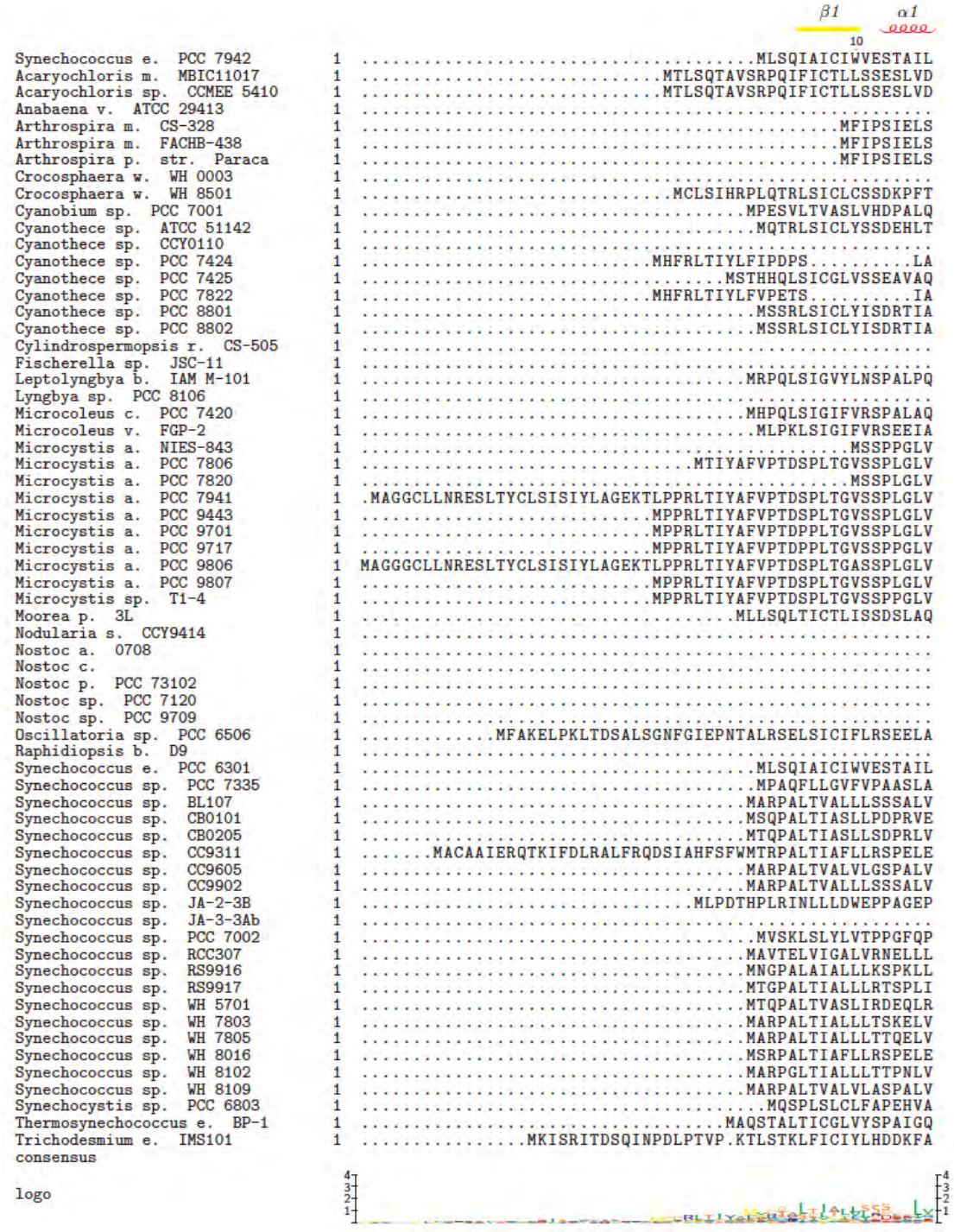
$$K_{Dobs2} = \frac{[A][C]}{[AC_2]} = \frac{(\gamma kd_1 + (1-\gamma)kd_2)}{(1-\gamma)(ka_1 + ka_2)}\ , \quad (13)$$

According to (11), (12) and (13), it is obvious that

$$K_{\mathrm{Dfit}} = \gamma\, K_{\mathrm{Dapp1}} = (1-\gamma)\, K_{\mathrm{Dapp2}} \quad (14)$$

Supplementary Figure S1. The sequence analyses of the clock proteins. (A) The sequence alignment of 65 KaiA sequences aligned in MEGA v5.05. The alignments were rendered with STRAP. The secondary structure elements were shown according to the protein structure of Synechococcus elongates PCC 7942. (B) The sequence alignment of 65 KaiB sequences aligned in MEGA v5.05. (C) The sequence alignment of 65 KaiC sequences aligned in MEGA v5.05. (D) The phylogenetic tree generated from concatenated KaiA/KaiB/KaiC sequences. (E) The calculated Relative Evolution Rates (RERs) of KaiA residues. (F) The calculated RERs of KaiC residues.

(A)


β1
α1
10
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Acaryochloris sp. CCMEE 5410 1 .....MTLSQTAVSRPQIFICTLLSSESLVD
Anabaena v. ATCC 29413 1 .....
Arthrospira m. CS-328 1 .....MFIPSIELS
Arthrospira m. FACHB-438 1 .....MFIPSIELS
Arthrospira p. str. Paraca 1 .....MFIPSIELS
Crocosphaera w. WH 0003 1 .....
Crocosphaera w. WH 8501 1 .....MCLSIHRPLQTRLSICLCSSDKPFT
Cyanobium sp. PCC 7001 1 .....MPESVLTVASLVHDPALQ
Cyanothece sp. ATCC 51142 1 .....MQTRLSICLYSSDEHLT
Cyanothece sp. CCY0110 1 .....
Cyanothece sp. PCC 7424 1 .....MHFRLTIYLFIPDPS.....LA
Cyanothece sp. PCC 7425 1 .....MSTHHQLSICGLVSSEAVAQ
Cyanothece sp. PCC 7822 1 .....MHFRLTIYLFVPETS.....IA
Cyanothece sp. PCC 8801 1 .....MSSRLSICLYISDRTIA
Cyanothece sp. PCC 8802 1 .....MSSRLSICLYISDRTIA
Cylindrospermopsis r. CS-505 1 .....
Fischerella sp. JSC-11 1 .....
Leptolyngbya b. IAM M-101 1 .....MRPQLSIGVYLNSPALPQ
Lyngbya sp. PCC 8106 1 .....
Microcoleus c. PCC 7420 1 .....MHPQLSIGIFVRSPALAQ
Microcoleus v. FGP-2 1 .....MLPKLSIGIFVRSEEIA
Microcystis a. NIES-843 1 .....MSSPPGLV
Microcystis a. PCC 7806 1 .....MTIYAFVPTDSPLTGVSSPLGLV
Microcystis a. PCC 7820 1 .....MSSPLGLV
Microcystis a. PCC 7941 1 .MAGGCLLNRESLTYCLSISIYLAGEKTLPPRLTIYAFVPTDSPLTGVSSPLGLV
Microcystis a. PCC 9443 1 .....MPPRLTIYAFVPTDSPLTGVSSPLGLV
Microcystis a. PCC 9701 1 .....MPPRLTIYAFVPTDPPLTGVSSPLGLV
Microcystis a. PCC 9717 1 .....MPPRLTIYAFVPTDPPLTGVSSPPGLV
Microcystis a. PCC 9806 1 MAGGGCLLNRESLTYCLSISIYLAGEKTLPPRLTIYAFVPTDSPLTGASSPLGLV
Microcystis a. PCC 9807 1 .....MPPRLTIYAFVPTDSPLTGVSSPLGLV
Microcystis sp. T1-4 1 .....MPPRLTIYAFVPTDSPLTGVSSPPGLV
Moorea p. 3L 1 .....MLLSQLTICTLISSDSLAQ
Nodularia s. CCY9414 1 .....
Nostoc a. 0708 1 .....
Nostoc c. 1 .....
Nostoc p. PCC 73102 1 .....
Nostoc sp. PCC 7120 1 .....
Nostoc sp. PCC 9709 1 .....
Oscillatoria sp. PCC 6506 1 .....MFAKELPKLTDSALSGNFGIEPNTALRSELSICIFLRSEELA
Raphidiopsis b. D9 1 .....
Synechococcus e. PCC 6301 1 .....MLSQIAICIWVESTAIL
Synechococcus sp. PCC 7335 1 .....MPAQFLLGVFVPAASLA
Synechococcus sp. BL107 1 .....MARPALTVALLLSSSALV
Synechococcus sp. CB0101 1 .....MSQPALTIASLLPDPRVE
Synechococcus sp. CB0205 1 .....MTQPALTIASLLSDPRLV
Synechococcus sp. CC9311 1 .....MACAAIERQTKIFDLRALFRQDSIAHFSFWMTRPALTIAFLLRSPELE
Synechococcus sp. CC9605 1 .....MARPALTVALVLGSPALV
Synechococcus sp. CC9902 1 .....MARPALTVALLLSSSALV
Synechococcus sp. JA-2-3B 1 .....MLPDTHPLRINLLLDWEPPAGEP
Synechococcus sp. JA-3-3Ab 1 .....
Synechococcus sp. PCC 7002 1 .....MVSKLSLYLVTPPGFQP
Synechococcus sp. RCC307 1 .....MAVTELVIGALVRNELLL
Synechococcus sp. RS9916 1 .....MNGPALAIALLLKSPKLL
Synechococcus sp. RS9917 1 .....MTGPALTIALLLRTSPLI
Synechococcus sp. WH 5701 1 .....MTQPALTVASLIRDEQLR
Synechococcus sp. WH 7803 1 .....MARPALTIALLLTSKELV
Synechococcus sp. WH 7805 1 .....MARPALTIALLLTTQELV
Synechococcus sp. WH 8016 1 .....MSRPALTIAFLLRSPELE
Synechococcus sp. WH 8102 1 .....MARPGLTIALLLTTPNLV
Synechococcus sp. WH 8109 1 .....MARPALTVALVLASPALV
Synechocystis sp. PCC 6803 1 .....MQSPLSLCLFAPEHVA
Thermosynechococcus e. BP-1 1 .....MAQSTALTICGLVYSPAIGQ
Trichodesmium e. IMS101 1 .....MKISRITDSQINPDLPTVP.KTLSTKLFICIYLHDDKFA
consensus
logo
4
3
2
1

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                                    α1          β2              α2            β3        α3
                                  20         30                40         50         60
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Acaryochloris m.  MBIC11017       27  LYTQILEGDRYSLVHAT.......YDN.FLEIVEQGKHRIDCLIFEKNAA....L
Acaryochloris sp.  CCMEE 5410     27  LYTRILEGDRYSLVHAT.......YDN.FLEIVEQGKHRIDCLIFEKNAA....L
Anabaena v.  ATCC 29413            1  .......................................................
Arthrospira m.  CS-328            10  QSVSSYLPKEHYIIIQLD......SPEEFIEYVTEHKHQLDCLILEWSPQ....W
Arthrospira m.  FACHB-438         10  QSVSSYLPKEHYIIIQPD......SPEEFIEYVTEHKHQLDCLILEWSPQ....W
Arthrospira p.  str.  Paraca      10  QSVSSYLPKEHYIIIQPD......SPEEFIEYVTEHKHQLDCLILEWSPQ....W
Crocosphaera w.  WH 0003           1  ..MANHLSGDRYRLHIID......QVEELIPFLKAHSETIDCLIVREEAS....I
Crocosphaera w.  WH 8501          26  QLLANHLSGDRYRLHIID......QVEELIPFLKAHSETIDCLIVREEAS....I
Cyanobium sp.  PCC 7001           19  AAVARWLAGGRYALVRVD......PSDDPVAALERLREDFDALLIEEGSVD....
Cyanothece sp.  ATCC 51142        18  QLLTHHLSGDRYRLHIID......QLEDLVPFLEDHSETIDCLIVKQEPS....I
Cyanothece sp.  CCY0110            1  ..MTHHLSSDRYRLHIID......QLQDLVPFLKEHSETIDCLIVRQEPS....I
Cyanothece sp.  PCC 7424          18  QSLTHLLSTERYNINLVD......SPNELIDVIEDNKEKIDCLVVLNQPS....L
Cyanothece sp.  PCC 7425          21  TLS.QALDDRFSLVQFQ.......QESDFRQFLEQEKHDIDCLVLESSLD....L
Cyanothece sp.  PCC 7822          18  QSLTRLLSTERYTLIFVN......SMDELLEAIEENKDKIDCLVVLKLPT....L
Cyanothece sp.  PCC 8801          18  QNLAEILADKPYCLKKVD......SPEELLKFVESRSEQIDCLIIFRDTT....V
Cyanothece sp.  PCC 8802          18  QNLAEILADKPYCLKKVD......SPEELLEFVESRSEQIDCLIIFRDTT....V
Cylindrospermopsis r.  CS-505     1  .......................................................
Fischerella sp.  JSC-11           1  .......................................................
Leptolyngbya b.  IAM M-101       19  SLEQILASHERYAMTVVE......STQDFFQLIQQHKQQLDCLILQDSSE....L
Lyngbya sp.  PCC 8106             1  ...MSSLQSDRYAVTQVH......SVEELLQYVSKEREQLDCLIVQVDMD....L
Microcoleus c.  PCC 7420         19  SLSQVLS.GDRYVLSITN......SASEFLEFVEQKQQHIDCLVLQDDDS....L
Microcoleus v.  FGP-2            18  ASAIELLRGERYALTHIK......SAVEFLGFLK.HNYHLDCLVLEVDGD....L
Microcystis a.  NIES-843          9  NSLTALLANERYHLTLGS......SSSELLANIEAQKEKIDCLLVVFHPS....L
Microcystis a.  PCC 7806         24  NSLTALLANERYNLTLGS......SSSELLANIEAEKEKIDCLLVVFHPS....L
Microcystis a.  PCC 7820          9  NSLTALLANERYNLTLGS......SSSELLANIEAEKEKIDCLLVVFHPS....L
Microcystis a.  PCC 7941         55  NSLTALLANERYNLTLGS......SSSELLANIEAEKEKIDCLLVVFHPS....L
Microcystis a.  PCC 9443         28  NSLTALLANERYNLTLGS......SSSELLANIEAEKEKIDCLLVFFHPS....L
Microcystis a.  PCC 9701         28  NSLTALLANERYNLTLGS......SSSELLANIEAQKEKIDCLLVVFHPS....L
Microcystis a.  PCC 9717         28  NSLTALLANERYHLTLGS......SSSELLANIEAQKEKIDCLLVVFHPS....L
Microcystis a.  PCC 9806         56  NSLTALLANERYNLTLGS......SSSELLANIEAEKEKIDCLLVVSHPS....L
Microcystis a.  PCC 9807         28  NSLTALLANERYNLTLGS......SSSELLANIEAQKEKIDCLLVVFHPS....L
Microcystis sp.  T1-4            28  NSLTALLANERYNLTLGS......SSSELLANIEAQKEKIDCLLVVFHPS....L
Moorea p.  3L                    20  SLSQVLG.SEQYIIHSTS......SESEFFEVVEQHKQDLDCLVLQDTDT....L
Nodularia s.  CCY9414             1  .......................................................
Nostoc a.  0708                   1  .......................................................
Nostoc c.                         1  .......................................................
Nostoc p.  PCC 73102              1  .......................................................
Nostoc sp.  PCC 7120              1  .......................................................
Nostoc sp.  PCC 9709              1  .......................................................
Oscillatoria sp.  PCC 6506       43  TSVLKLLDRNRYILMRSN......SPEGFLDFIQ.RNSHLDCLVFEVYPE....L
Raphidiopsis b.  D9               1  .......................................................
Synechococcus e.  PCC 6301       18  QDCQRALSADRYQLQVCE......SGEMLLEYAQTHRDQIDCLILVAANP...SF
Synechococcus sp.  PCC 7335     18  EPLQQLLAQQQFVVSWSQ......SASEFEEWVVSNRHRIDCLIIQSAEE....S
Synechococcus sp.  BL107         19  DLCRQWLPANRYESVVLS....VGDNEGLATTLAPRHDDFDAVVIEQNLLD....
Synechococcus sp.  CB0101        19  RACRSWLKGGRYQLEDLG......SLADPILELQQQRDRFDVVLLQQGVHP....
Synechococcus sp.  CB0205        19  KAATSWLKGERYCLEDLG......SLSDPIAELLQRRDAFDVVLLQQGVTP....
Synechococcus sp.  CC9311        49  SACCQWLPGNRYTPVDLG...LEDSAVDVVSALERQREAVDAVVIEQSLLQ....
Synechococcus sp.  CC9605        19  EACRPWLPANRYESVVLT....VDPGETLAAVLGPRQDDFDAVVLEQSLLD....
Synechococcus sp.  CC9902        19  DTCRQWLPANRYESVVLS....VGENEGLATTLAPRHNDFDAVVVEQNLLD....
Synechococcus sp.  JA-2-3B       24  LACEDWLPPERFVVECFQ......DQATFLEALRKQDGHVDCLVLLVDPTRLQEL
Synechococcus sp.  JA-3-3Ab       1  ......MSPERFVAEVFQ......DPEAFLEALRGEENHPDCLVLLVEATRLDKL
Synechococcus sp.  PCC 7002     18  GKIEAQLIGDRYQIKLLD......YGQKFLAFLEANKEQIDCLVVVQGKE....N
Synechococcus sp.  RCC307        19  KSCRQWLREADRFRLEVIP....LNPESLFDALQERWEDLDGVLIEQGALD....
Synechococcus sp.  RS9916        19  PACRSWLPENRYTVVDLG...LTGGVTDFQAALEQQREAVDAVVIEQSLLE....
Synechococcus sp.  RS9917        19  ETCRQWLPGNRYTPVDLG...LNRETTDLRQVLEGQREAVDAVVIEQSLLT....
Synechococcus sp.  WH 5701       19  QACSTWLPQGRYELMELG......LQQDPAAELERCWEQFDAVLLEPGVLS....
Synechococcus sp.  WH 7803       19  DACTQWLPVNRYKPVDLH...QAASGEGLLEVLAHQREAVDAVVIEQSLLD....
Synechococcus sp.  WH 7805       19  DACRQWLPVNRYKPVDLQ...QTASGQALLEVLSHQREAVDAVVIEQSLLD....
Synechococcus sp.  WH 8016       19  SACCQWLPGNRYTRVDLG...LEDSAVDVVSALERQREAVDAVVIEQSLLE....
Synechococcus sp.  WH 8102       19  DACQQWLPDTRYHSIVLSGPHQGQEQLDLVSTLEAQQEEIDAVVVEQQLLD....
Synechococcus sp.  WH 8109       19  EACRPWLPANRYESVVLT....VDPGETLAAVLGPRQNDFDAVVLEQSLLD....
Synechocystis sp.  PCC 6803      17  HRLRSIFQGDRHYLSTFQ......ALDDFCAFLEDKPERIDCLLVYYEAN....S
Thermosynechococcus e.  BP-1     21  ELVRLHTSDIDELVYFS.......SEREFCNYLEARRNSIACLILEWGEG....T
Trichodesmium e.  IMS101        39  TSVTKLLSQDRYLVALTK......SDREFVQLIEENTN.IDCLLFQEDPE....L
consensus                                        *                     *      * ***
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                                    α3          β4
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Acaryochloris m.  MBIC11017     70  PKVVSHLHREAILLPAVLLQVEESVEKTSQPNSAD..............RDPQQD
Acaryochloris sp.  CCMEE 5410   70  PKVVSHLHREAILLPAVLLQVEESVEKTSQPNSAD..............RDPQQD
Anabaena v.  ATCC 29413          1  .......................................................
Arthrospira m.  CS-328          55  QVLVDKLQQNLISIPTLIIIPNEQSPVVQPSLTEP.................SEN
Arthrospira m.  FACHB-438       55  QGLVNKLQQNLVSIPTLIIISDEQSPVVQPSLTEP.................SEN
Arthrospira p.  str.  Paraca    55  QGLVNKLQQNLVSIPTLIIISDEQSPVVQPSLTEP.................SEN
Crocosphaera w.  WH 0003        44  LPLFNQLYERGTLLPVIIVE..KGEDPS.................IALANVESPT
Crocosphaera w.  WH 8501        71  LPLFNQLYERGTLLPVIIVE..KGEDPS.................IALANVESPT
Cyanobium sp.  PCC 7001         64  PSVFAGLNQRGLVLPAVVIGAVTG..............................E
Cyanothece sp.  ATCC 51142      63  LPLFNQLYEQGTLVPVIIFE..DKVES....................SDNVEPPT
Cyanothece sp.  CCY0110         44  FPLFNQLYEQGTLLPIIIFE..EEDSS..................ASSVNVDSPT
Cyanothece sp.  PCC 7424        63  LPLFNQLYEEGILLPIVLLETPIENTAPMTGGQ.....ENGEENQKAAKLSEAPT
Cyanothece sp.  PCC 7425        64  PQVACYLHKEATLLPAIVLLSNP...SPSAASESD..............KLWHED
Cyanothece sp.  PCC 7822        63  LPLFNQLYEEGVLLPVVLLESPSTSLSELYNATPPAIAESRLPEESPSSPKDAPT
Cyanothece sp.  PCC 8801        63  SPLFNQLYEQGTLLPVIILDSELDSQAS.................TQSENMETAT
Cyanothece sp.  PCC 8802        63  SPLFNQLYEQGTLLPVIILDSELDSQAS.................TQSENMETAT
Cylindrospermopsis r.  CS-505    1  .............................................MILVILFLYP
Fischerella sp.  JSC-11          1  .......................................................
Leptolyngbya b.  IAM M-101      64  PAIIEWLHSQATLLPAILVESEPHTTR.......................PPDFT
Lyngbya sp.  PCC 8106           43  TVLVDQFRQQGISLPIVILDSQIQSSQPTAQSETSGST.........QSFSDSPN
Microcoleus c.  PCC 7420        63  PPVINQLYEQGTLLPLVIFPKESKNNDSFVVTNAQSNPI....QTTVRCTPGEVH
Microcoleus v.  FGP-2           62  RSLLGKLQERSLFLPAVIFSPHLQVDGRPEAPYSDGFEAV..ASTANKSQDESCA
Microcystis a.  NIES-843        54  QPTFNQLYEGGILLPVVIIVADKN.....................ITAKTNDSPT
Microcystis a.  PCC 7806        69  QPTFNQLYEGGILLPVVIIVADKN.....................IAPEMNDSPT
Microcystis a.  PCC 7820        54  QPTFNQLYEGGILLPVVIIVADKN.....................IAPEMNDSPT
Microcystis a.  PCC 7941       100  QPTFNQLYEGGILLPVVIIVADKN.....................IAPEMNDSPT
Microcystis a.  PCC 9443        73  QPTFNQLYEGGILLPVVIIVADKN.....................IAPETNDSPT
Microcystis a.  PCC 9701        73  QPTFNQLYEGGILLPVVIIVADKN.....................ITAETNDSPT
Microcystis a.  PCC 9717        73  QPTFNQLYEGGILLPVVIIVADKN.....................ITAETNDSPT
Microcystis a.  PCC 9806       101  QPTFNQLYEAGILLPVVIIVADNN.....................ITAGTNDSPT
Microcystis a.  PCC 9807        73  QPTFNQLYEGGILLPVVIIVADKN.....................IAPETNDSPT
Microcystis sp.  T1-4           73  QPTFNQLYEAGVLLPVVIIVADKN.....................ITAGTNDSPT
Moorea p.  3L                   64  PKVIHYLYLQGTTLPAVFLRSDSPEIPPRVDSNQQLASN....QTTDKFTARSSA
Nodularia s.  CCY9414            1  .......................................................
Nostoc a.  0708                  1  ......................................M......ILPILLIWLL
Nostoc c.                        1  .............................................MLLPILFFQP
Nostoc p.  PCC 73102             1  .............................................MLLPILILRP
Nostoc sp.  PCC 7120             1  .......................................................
Nostoc sp.  PCC 9709             1  .............................................MLLPILILPP
Oscillatoria sp.  PCC 6506      87  HLLVSQLQEHSIFLPVVILEAEANSEDAKLLPENQ.......AMTSEDSHEENLH
Raphidiopsis b.  D9              1  .......................................................
Synechococcus e.  PCC 6301      64  RAVVQQLCFEGVVVPAIVVGDRDSEDPD......................EPAKE
Synechococcus sp.  PCC 7335     63  LQVLLHLKEKDILLPAVALYSSKAPSTHSELSDSAVFL.......QGQRTYHQAV
Synechococcus sp.  BL107        66  SDAREDLLKAGLLFPAVIVGEVKG..............................H
Synechococcus sp.  CB0101       64  PEVYEELQQQGLLLPAVVIGEVSG..............................R
Synechococcus sp.  CB0205       64  PEALQGLRQQGVLLPAVVVGEVNG..............................R
Synechococcus sp.  CC9311       97  EQIREDLLARGLLFPAVVVGELMG..............................R
Synechococcus sp.  CC9605       66  AEVKEQLLAAGLLFPAVIVGEVKG..............................Q
Synechococcus sp.  CC9902       66  SEAREDLLKAGLLFPAVIVGEVKG..............................H
Synechococcus sp.  JA-2-3B      73  HDLGNQLCAWGLLLPTVLAIVLEESHLQKETP..ETEGEIPATSSLVKALLKREQ
Synechococcus sp.  JA-3-3Ab     44  EALGCQLCKQGLLLPTVVAIVSEELKPEGGASR.SGEASSPPVPPGARALLKRER
Synechococcus sp.  PCC 7002     63  QDYFECLTQSGILLPCVFLGPTTACEIS.....................QEDVSE
Synechococcus sp.  RCC307       66  RHGLDQLRTQGMLLPAVVLGDVTG..............................E
Synechococcus sp.  RS9916       67  PDLRRSLLEAGLLFPAVVVGEVMG..............................R
Synechococcus sp.  RS9917       67  PEVRQSLLEAGLLFPAVVVGEVMG..............................H
Synechococcus sp.  WH 5701      64  IEAFQRLRAQGRILPAVVLGQLSG..............................P
Synechococcus sp.  WH 7803      67  ETTREGLRRGGLLFPAVVVGELMG..............................R
Synechococcus sp.  WH 7805      67  ESTREGLRREGLLFPAVVVGELMG..............................R
Synechococcus sp.  WH 8016      67  EQTREDLLARGLLFPAVVVGELMG..............................R
Synechococcus sp.  WH 8102      70  ASSRDQLLGRGLLFPAVVVGEMKG..............................H
Synechococcus sp.  WH 8109      66  AEAKEQLLASGLLFPAVIVGEVKG..............................Q
Synechocystis sp.  PCC 6803     62  LPVLNRLYEQGRLLPIILLEPSPS....................ALAKTTDEHPT
Thermosynechococcus e.  BP-1    65  PQIITYLHHSATLLPAILIFPAA...PAPPPAG......................
Trichodesmium e.  IMS101        83  TSLIHKLHHRSILLPAVIIKKSESENSLENQQLTDTDNN....FTEYTTQHNYQP
consensus                                 *       * ***
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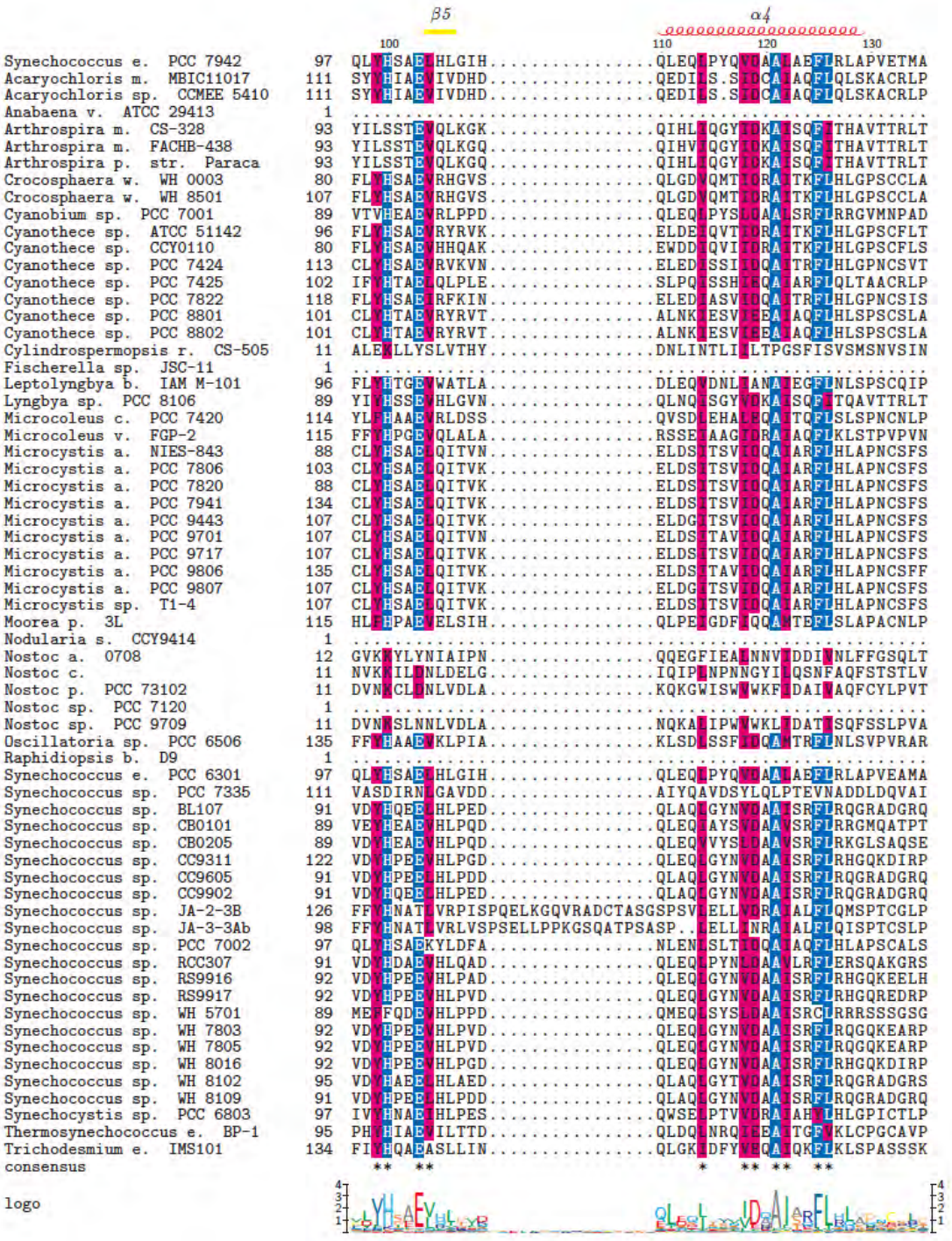
β5
α4
100
110
120
130
Synechococcus e. PCC 7942 97 QLYHSAEVHLGIH.....QLEQLPYQVDAALAEFLRLAPVETMA
Acaryochloris m. MBIC11017 111 SYYHIAEVIVDHD.....QEDILS.SIDCALAQFLQLSKACRLP
Acaryochloris sp. CCMEE 5410 111 SYYHIAEVIVDHD.....QEDILS.SIDCALAQFLQLSKACRLP
Anabaena v. ATCC 29413 1 .....
Arthrospira m. CS-328 93 YILSSTEVQLKGK.....QIHLIQGYIDKALSQFITHAVTTRLT
Arthrospira m. FACHB-438 93 YILSSTEVQLKGQ.....QIHVIQGYIDKALSQFITHAVTTRLT
Arthrospira p. str. Paraca 93 YILSSTEVQLKGQ.....QIHLIQGYIDKALSQFITHAVTTRLT
Crocosphaera w. WH 0003 80 FLYHSAEVRHGVS.....QLGDVQMTIDRALTKFLHLGPSCCLA
Crocosphaera w. WH 8501 107 FLYHSAEVRHGVS.....QLGDVQMTIDRALTKFLHLGPSCCLA
Cyanobium sp. PCC 7001 89 VTVHEAEVRLPPD.....QLEQLPYSLQAALSRFLRRGVMNPAD
Cyanothece sp. ATCC 51142 96 FLYHSAEVRYRVK.....ELDEIQVTIDRALTKFLHLGPSCFLT
Cyanothece sp. CCY0110 80 FLYHSAEVHHQAK.....EWDDIQVIIDRALTKFLHLGPSCFLS
Cyanothece sp. PCC 7424 113 CLYHSAEVRVKVN.....ELEDISSIIDQALTRFLHLGPNCSVT
Cyanothece sp. PCC 7425 102 IFYHTAEVQLPLE.....SLPQISSHIEQALARFLQLTAACRLP
Cyanothece sp. PCC 7822 118 FLYHSAEVRFKIN.....ELEDIASVIDQALTRFLHLGPNCSIS
Cyanothece sp. PCC 8801 101 CLYHTAEVRYRVT.....ALNKIESVIEEALAQFLHLSPSCSLA
Cyanothece sp. PCC 8802 101 CLYHTAEVRYRVT.....ALNKIESVIEEALAQFLHLSPSCSLA
Cylindrospermopsis r. CS-505 11 ALEKLLYSLVTHY.....DNLINTLIILTPGSFISVSMSNVSIN
Fischerella sp. JSC-11 1 .....
Leptolyngbya b. IAM M-101 96 FLYHTGEVWATLA.....DLEQVDNLIANALEGFLNLSPSCQIP
Lyngbya sp. PCC 8106 89 YIYHSSEVHLGVN.....QLNQISGYVDKALSQFITQAVTTRLT
Microcoleus c. PCC 7420 114 YLFHAAEVRLDSS.....QVSDLEHALEQALTQFLSLSPNCNLP
Microcoleus v. FGP-2 115 FFYHPGEVQLALA.....RSSEIAAGIDRALAQFLKLSTPVPVN
Microcystis a. NIES-843 88 CLYHSAEVQITVN.....ELDSITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 7806 103 CLYHSAEVQITVK.....ELDSITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 7820 88 CLYHSAEVQITVK.....ELDSITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 7941 134 CLYHSAEVQITVK.....ELDSITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 9443 107 CLYHSAEVQITVK.....ELDGITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 9701 107 CLYHSAEVQITVN.....ELDSITAVIDQALARFLHLAPNCSFS
Microcystis a. PCC 9717 107 CLYHSAEVQITVK.....ELDSITSVIDQALARFLHLAPNCSFS
Microcystis a. PCC 9806 135 CLYHSAEVQITVK.....ELDSITAVIDQALARFLHLAPNCSFF
Microcystis a. PCC 9807 107 CLYHSAEVQITVK.....ELDGITSVIDQALARFLHLAPNCSFS
Microcystis sp. T1-4 107 CLYHSAEVQITVK.....ELDSITSVIDQALARFLHLAPNCSFS
Moorea p. 3L 115 HLFHPAEVELSIH.....QLPEIGDFIQQALTEFLSLAPACNLP
Nodularia s. CCY9414 1 .....
Nostoc a. 0708 12 GVKKYLYNIAIPN.....QQEGFIEALNNVIDDINNLFFGSQLT
Nostoc c. 11 NVKNILDNLDELG.....IQIPLNPNNGYILQSNFAQFSTSTLV
Nostoc p. PCC 73102 11 DVNKCLDNLVDLA.....KQKGWISWVWKFLDAIVAQFCYLPVT
Nostoc sp. PCC 7120 1 .....
Nostoc sp. PCC 9709 11 DVNMSLNNLVDLA.....NQKALIPWVWKLIDATISQFSSLPVA
Oscillatoria sp. PCC 6506 135 FFYHAAEVKLPIA.....KLSDLSSFIDQALTRFLNLSVPVRAR
Raphidiopsis b. D9 1 .....
Synechococcus e. PCC 6301 97 QLYHSAEIHLGIH.....QLEQLPYQVDAALAEFLRLAPVEAMA
Synechococcus sp. PCC 7335 111 VASDIRNIGAVDD.....AIYQAVDSYLQLPTEVNADDLDQVAI
Synechococcus sp. BL107 91 VDYHQEEVHLPED.....QLAQLGYNVDAALSRFLRQGRADGRQ
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Synechococcus sp. CC9311 122 VDYHPEEVHLPGD.....QLEQLGYNVDAALSRFLRHGQKDIRP
Synechococcus sp. CC9605 91 VDYHPEEVHLPDD.....QLAQLGYNVDAALSRFLRQGRADGRQ
Synechococcus sp. CC9902 91 VDYHQEEVHLPED.....QLAQLGYNVDAALSRFLRQGRADGRQ
Synechococcus sp. JA-2-3B 126 FFYHNATLVRPISPQELKGQVRADCTASGSPSVLELLVDRALALFLQMSPTCGLP
Synechococcus sp. JA-3-3Ab 98 FFYHNATLVRLVSPSELLPPKGSQATPSASP..LELLINRALALFLQISPTCSLP
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Synechococcus sp. RCC307 91 VDYHDAEVHLQAD.....QLEQLPYNLQAAVLRFLERSQAKGRS
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Synechococcus sp. WH 7805 92 VDYHPEEVHLPVD.....QLEQLGYNVDAALSRFLRQGQKEARP
Synechococcus sp. WH 8016 92 VDYHPEEVHLPGD.....QLEQLGYNVDAALSRFLRHGQKDIRP
Synechococcus sp. WH 8102 95 VDYHAEEVHLAED.....QLAQLGYTVDAALSRFLRQGRADGRS
Synechococcus sp. WH 8109 91 VDYHPEEVHLPDD.....QLAQLGYNVDAALSRFLRQGRADGRQ
Synechocystis sp. PCC 6803 97 IVYHNAEVHLPES.....QWSELPTVVDRALAHYLHLGPICTLP
Thermosynechococcus e. BP-1 95 PHYHIAEVILTTD.....QLDQLNRQIEEALTGFVKLCPGCAVP
Trichodesmium e. IMS101 134 FIYHQAEASLLIN.....QLGKIDFYVEQALQKFLKLSPASSSK
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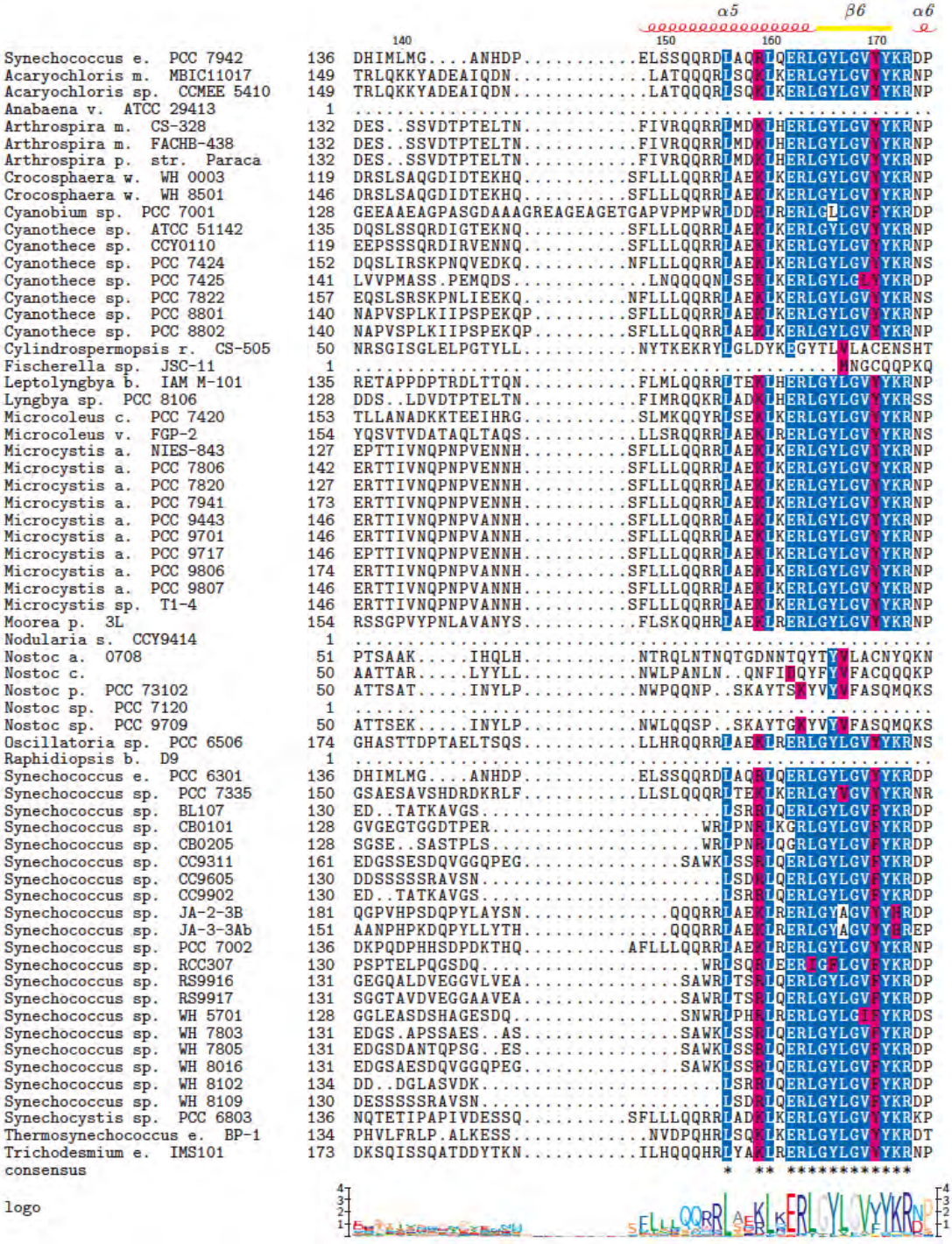
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Acaryochloris m. MBIC11017 149 TRLQKKYADEAIQDN.............LATQQQRLSQALKERLGYLGVYYKRNP
Acaryochloris sp. CCMEE 5410 149 TRLQKKYADEAIQDN.............LATQQQRLSQALKERLGYLGVYYKRNP
Anabaena v. ATCC 29413 1 ....
Arthrospira m. CS-328 132 DES..SSVDTPTELTN..........FIVRQQRRLMDALHERLGYLGVYYKRNP
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Arthrospira p. str. Paraca 132 DES..SSVDTPTELTN..........FIVRQQRRLMDALHERLGYLGVYYKRNP
Crocosphaera w. WH 0003 119 DRSLSAQGDIDTEKHQ..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Crocosphaera w. WH 8501 146 DRSLSAQGDIDTEKHQ..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Cyanobium sp. PCC 7001 128 GEEAAEAGPASGDAAAGREAGEAGETGAPVPMPWRLDDALRERLGLLGVFYKRDP
Cyanothece sp. ATCC 51142 135 DQSLSSQRDIGTEKNQ..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Cyanothece sp. CCY0110 119 EEPSSSQRDIRVENNQ..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Cyanothece sp. PCC 7424 152 DQSLIRSKPNQVEDKQ..........NFLLLQQRRLAEALKERLGYLGVYYKRNS
Cyanothece sp. PCC 7425 141 LVVPMASS.PEMQDS............LNQQQQNLSEALKERLGYLGLYYKRDP
Cyanothece sp. PCC 7822 157 EQSLSRSKPNLIEEKQ..........NFLLLQQRRLAEALKERLGYLGVYYKRNS
Cyanothece sp. PCC 8801 140 NAPVSPLKIIPSPEKQP.........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Cyanothece sp. PCC 8802 140 NAPVSPLKIIPSPEKQP.........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Cylindrospermopsis r. CS-505 50 NRSGISGLELPGTYLL..........NYTKEKRYLGLDYKEGYTLWLACENSHT
Fischerella sp. JSC-11 1 ....MNGCQQPKQ
Leptolyngbya b. IAM M-101 135 RETAPPDPTRDLTTQN..........FLMLQQRRLTEALHERLGYLGVYYKRNP
Lyngbya sp. PCC 8106 128 DDS..LDVDTPTELTN..........FIMRQQKRLADALHERLGYLGVYYKRSS
Microcoleus c. PCC 7420 153 TLLANADKKTEEIHRG..........SLMKQQYRLSEALKERLGYLGVYYKRNP
Microcoleus v. FGP-2 154 YQSVTVDATAQLTAQS..........LLSRQQRRLAEALRERLGYLGVYYKRNS
Microcystis a. NIES-843 127 EPTTIVNQPNPVENNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Microcystis a. PCC 7806 142 ERTTIVNQPNPVENNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
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Microcystis a. PCC 7941 173 ERTTIVNQPNPVENNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
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Microcystis a. PCC 9701 146 ERTTIVNQPNPVANNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Microcystis a. PCC 9717 146 EPTTIVNQPNPVENNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Microcystis a. PCC 9806 174 ERTTIVNQPNPVANNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Microcystis a. PCC 9807 146 ERTTIVNQPNPVANNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Microcystis sp. T1-4 146 ERTTIVNQPNPVANNH..........SFLLLQQRRLAEALKERLGYLGVYYKRNP
Moorea p. 3L 154 RSSGPVYPNLAVANYS..........FLSKQQHRLAEALRERLGYLGVYYKRNP
Nodularia s. CCY9414 1 ....
Nostoc a. 0708 51 PTSAAK.....IHQLH..........NTRQLNTNQTGDNNTQYTYWLACNYQKN
Nostoc c. 50 AATTAR.....LYYLL..........NWLPANLN..QNFIRQYFYYFACQQQKP
Nostoc p. PCC 73102 50 ATTSAT.....INYLP..........NWPQQNP..SKAYTSKYVYYFASQMQKS
Nostoc sp. PCC 7120 1 ....
Nostoc sp. PCC 9709 50 ATTSEK.....INYLP..........NWLQQSP..SKAYTGKYVYYFASQMQKS
Oscillatoria sp. PCC 6506 174 GHASTTDPTAELTSQS..........LLHRQQRRLAEALRERLGYLGVYYKRNS
Raphidiopsis b. D9 1 ....
Synechococcus e. PCC 6301 136 DHIMLMG....ANHDP..........ELSSQQRDLAQALQERLGYLGVYYKRDP
Synechococcus sp. PCC 7335 150 GSAESAVSHDRDKRLF..........LLSLQQQRLTEALKERLGYLGVYYKRNR
Synechococcus sp. BL107 130 ED..TATKAVGS..............LSRALQERLGYLGVFYKRDP
Synechococcus sp. CB0101 128 GVGEGTGGDTPER..............WRLPNALKGRLGYLGVFYKRDP
Synechococcus sp. CB0205 128 SGSE..SASTPLS..............WRLPNALQGRLGYLGVFYKRDP
Synechococcus sp. CC9311 161 EDGSSESDQVGGQPEG..........SAWKLSSALQERLGYLGVFYKRDP
Synechococcus sp. CC9605 130 DDSSSSSRAVSN..............LSDALQERLGYLGVFYKRDP
Synechococcus sp. CC9902 130 ED..TATKAVGS..............LSRALQERLGYLGVFYKRDP
Synechococcus sp. JA-2-3B 181 QGPVHPSDQPYLAYSN..........QQQRRLAEALRERLGYAGVYYTRDP
Synechococcus sp. JA-3-3Ab 151 AANPHPKDQPYLLYTH..........QQQRRLAEALRERLGYAGVYYGREP
Synechococcus sp. PCC 7002 136 DKPQDPHHSDPDKTHQ..........AFLLLQQRRLAEALRERLGYLGVYYKRNP
Synechococcus sp. RCC307 130 PSPTELPQGSDQ..............WRLSQALEERLGGLGVFYKRDP
Synechococcus sp. RS9916 131 GEGQALDVEGGVLVEA..........SAWRLTSALQERLGYLGVFYKRDP
Synechococcus sp. RS9917 131 SGGTAVDVEGGAAVEA..........SAWRLTSALQERLGYLGVFYKRDP
Synechococcus sp. WH 5701 128 GGLEASDSHAGESDQ..........SNWRLPHALRERLGYLGIFYKRDS
Synechococcus sp. WH 7803 131 EDGS.APSSAES..AS..........SAWKLSSALQERLGYLGVFYKRDP
Synechococcus sp. WH 7805 131 EDGSDANTQPSG..ES..........SAWKLSSALQERLGYLGVFYKRDP
Synechococcus sp. WH 8016 131 EDGSAESDQVGGQPEG..........SAWKLSSALQERLGYLGVFYKRDP
Synechococcus sp. WH 8102 134 DD..DGLASVDK..............LSRALQERLGYLGVFYKRDP
Synechococcus sp. WH 8109 130 DESSSSSRAVSN..............LSDALQERLGYLGVFYKRDP
Synechocystis sp. PCC 6803 136 NQTETIPAPIVDESSQ..........SFLLLQQRRLADALKERLGYLGVYYKRKP
Thermosynechococcus e. BP-1 134 PHVLFRLP.ALKESS..........NVDPQHRLSQALKERLGYLGVYYKRDT
Trichodesmium e. IMS101 173 DKSQISSQATDDYTKN..........ILHQQQHRLYALRERLGYLGVYYKRNP
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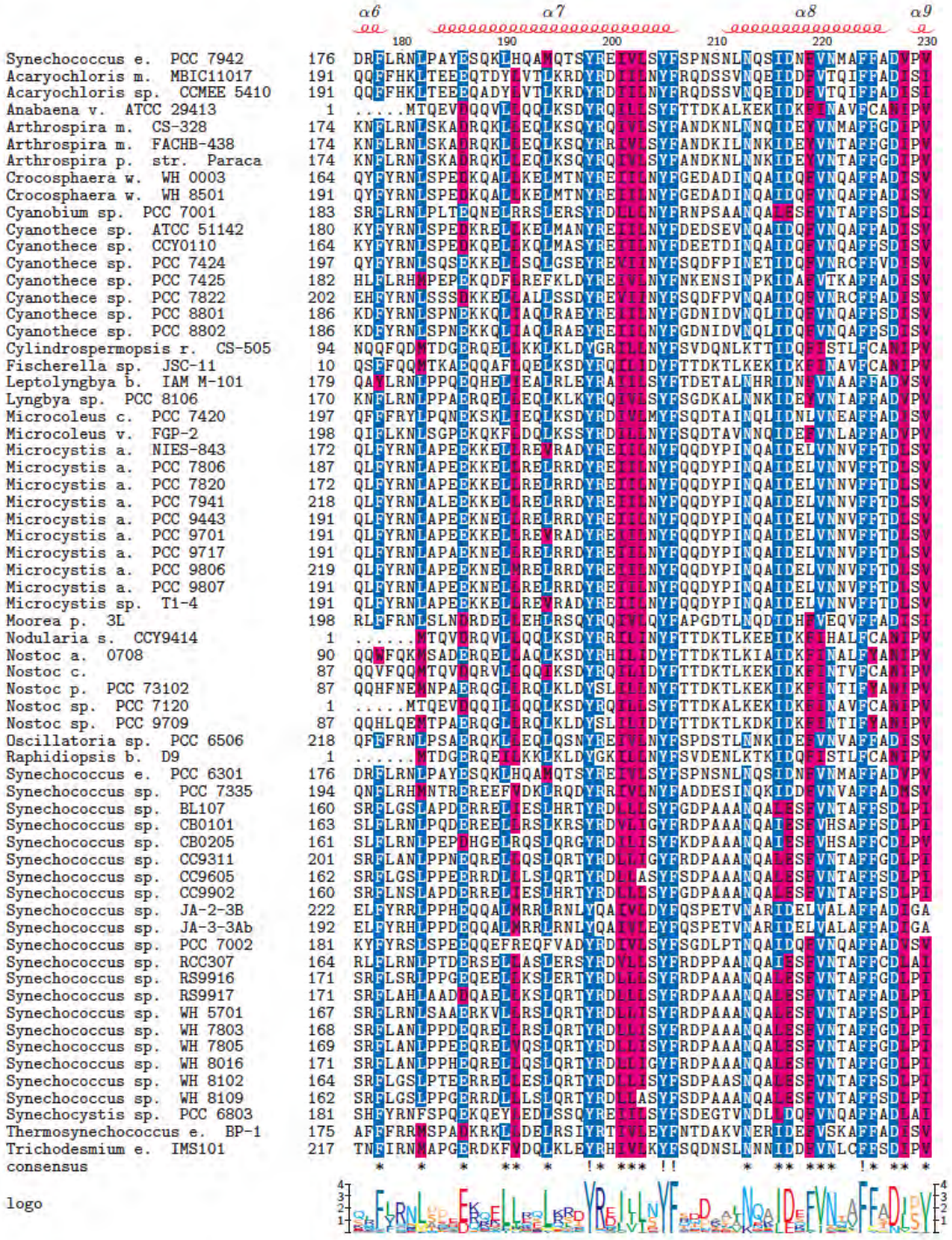
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Acaryochloris m. MBIC11017 191 QQFFHKLTEEEQTDYIVTLKRDYRDIILNYFRQDSSVNQEIDDFVTQIFFADISI
Acaryochloris sp. CCMEE 5410 191 QQFFHKLTEEEQADYIVTLKRDYRDIILNYFRQDSSVNQEIDDFVTQIFFADISI
Anabaena v. ATCC 29413 1 .....MTQEVDQQVLQQLKSDYRQILLSYFTTDKALKEKIDKFINAVFCANIPV
Arthrospira m. CS-328 174 KNFLRNLSKADRQKLEQLKSQYRQIVLSYFANDKNLNNQIDEFVNMAFFGDIPV
Arthrospira m. FACHB-438 174 KNFLRNLSKADRQKLEQLKSQYRRIVLSYFANDKILNNKIDEFVNTAFFGDIPV
Arthrospira p. str. Paraca 174 KNFLRNLSKADRQKLEQLKSQYRQIVLSYFANDKNLNNKIDEFVNTAFFGDIPV
Crocosphaera w. WH 0003 164 QYFYRNLSPEDKQALKELMTNYREIILNYFGEDADINQAIDQFVNQAFFADISV
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Cyanobium sp. PCC 7001 183 SRFLRNLPLTEQNELRRSLERSYRDLLLNYFRNPSAANQALESFVNTAFFSDISI
Cyanothece sp. ATCC 51142 180 KYFYRNLSPEDKRELKELMANYREIILNYFDEDSEVNQAIDQFVNQAFFADISV
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Cyanothece sp. PCC 7425 182 HLFLRHMPEPEKQDFLREFKLDYREIVLNYFNKENSINPKIDAFVTKAFFADISV
Cyanothece sp. PCC 7822 202 EHFYRNLSSSDKKELLALLSSDYREVIINYFSQDFPVNQAIDQFVNRCFFADISV
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Cyanothece sp. PCC 8802 186 KDFYRNLSPNEKKQLIAQLRAEYREIILNYFGDNIDVNQLIDQFVNQAFFSDISV
Cylindrospermopsis r. CS-505 94 NQQFQDMTDGERQELKKLKLDYGRILLNYFSVDQNLKTTIDQFISTLFCANIPV
Fischerella sp. JSC-11 10 QSFFQQMTKAEQQAFLQELKSDYRQILIDYFTTDKTLKEKIDKFINAVFCANIPV
Leptolyngbya b. IAM M-101 179 QAWLRNLPPQEQHELLEALRLEYRAILSYFTDETALNHRIDNFVNAAFFADVSV
Lyngbya sp. PCC 8106 170 KNFLRNLPPAERQELLEQLKLKYRQIVLSYFSGDKALNNKIDEFVNIAFFADVPV
Microcoleus c. PCC 7420 197 QFFFRYLPQNEKSKLLEQLKSDYRDIVLMYFSQDTAINQLIDNLVNEAFFADISV
Microcoleus v. FGP-2 198 QIFLKNLSGPEKQKFLDQLKSSYRDILLNYFSQDTAVNNQIDEFVNLAFFADVPV
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Microcystis a. PCC 9701 191 QLFYRNLAPEEKKELLREVRADYREIILNYFQQDYPINQAIDELVNNVFFTDLSV
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Microcystis sp. T1-4 191 QLFYRNLAPEEKKELLREVRADYREIILNYFQQDYPINQAIDELVNNVFFTDLSV
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Oscillatoria sp. PCC 6506 218 QFFFRNLPSAERQKLLEQLQSNYREIVLNYFSPDSTLNNKIDEFVNVAFFADISV
Raphidiopsis b. D9 1 ......MTDGERQELLKKLKLDYGKILLNYFSVDENLKTKIDQFISTLFCANIPV
Synechococcus e. PCC 6301 176 DRFLRNLPAYESQKLHQAMQTSYREIVLSYFSPNSNLNQSIDNFVNMAFFADVPV
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Synechococcus sp. CB0205 161 SLFLRNLPEPDHGELRQSLQRGYRDILISYFKDPAAANQAIESFVHSAFFCDLPV
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Synechococcus sp. CC9902 160 SRFLNSLAPDERREFLESLHRTYRDLLLSYFGDPAAANQALESFVNTAFFSDLPI
Synechococcus sp. JA-2-3B 222 ELFYRRLPPHEQQALMRRLRNLYQAIVLDYFQSPETVNARIDELVALAFFADIGA
Synechococcus sp. JA-3-3Ab 192 ELFYRHLPPDEQQALMRRLRNLYQAIVLEYFQSPETVNARIDELVALAFFADIGA
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Synechococcus sp. RS9916 171 SRFLSRLPPGEQEELLKSLERTYRDLLLSYFRDPAAANQALESFVNTAFFGDLPI
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Synechococcus sp. WH 8102 164 SRFLGSLPTEERRELLESLQRTYRDLLISYFSDPAASNQALESFVNTAFFSDLPI
Synechococcus sp. WH 8109 162 SRFLGSLPPGERRDLLLSLQRTYRDLLASYFSDPAAANQALESFVNTAFFSDLPI
Synechocystis sp. PCC 6803 181 SHFYRNFSPQEKQEYLEDLSSQYREIILSYFSDEGTVNDLLDQFVNQAFFADLAI
Thermosynechococcus e. BP-1 175 AFFFRRMSPADKRKLLDELRSIYRTIVLEYFNTDAKVNERIDEFVSKAFFADISV
Trichodesmium e. IMS101 217 TNFIRNMAPGERDKFVDQLKLEYRHIVLKYFSQDNSLNNNIDDFVNLCFFSDLPV
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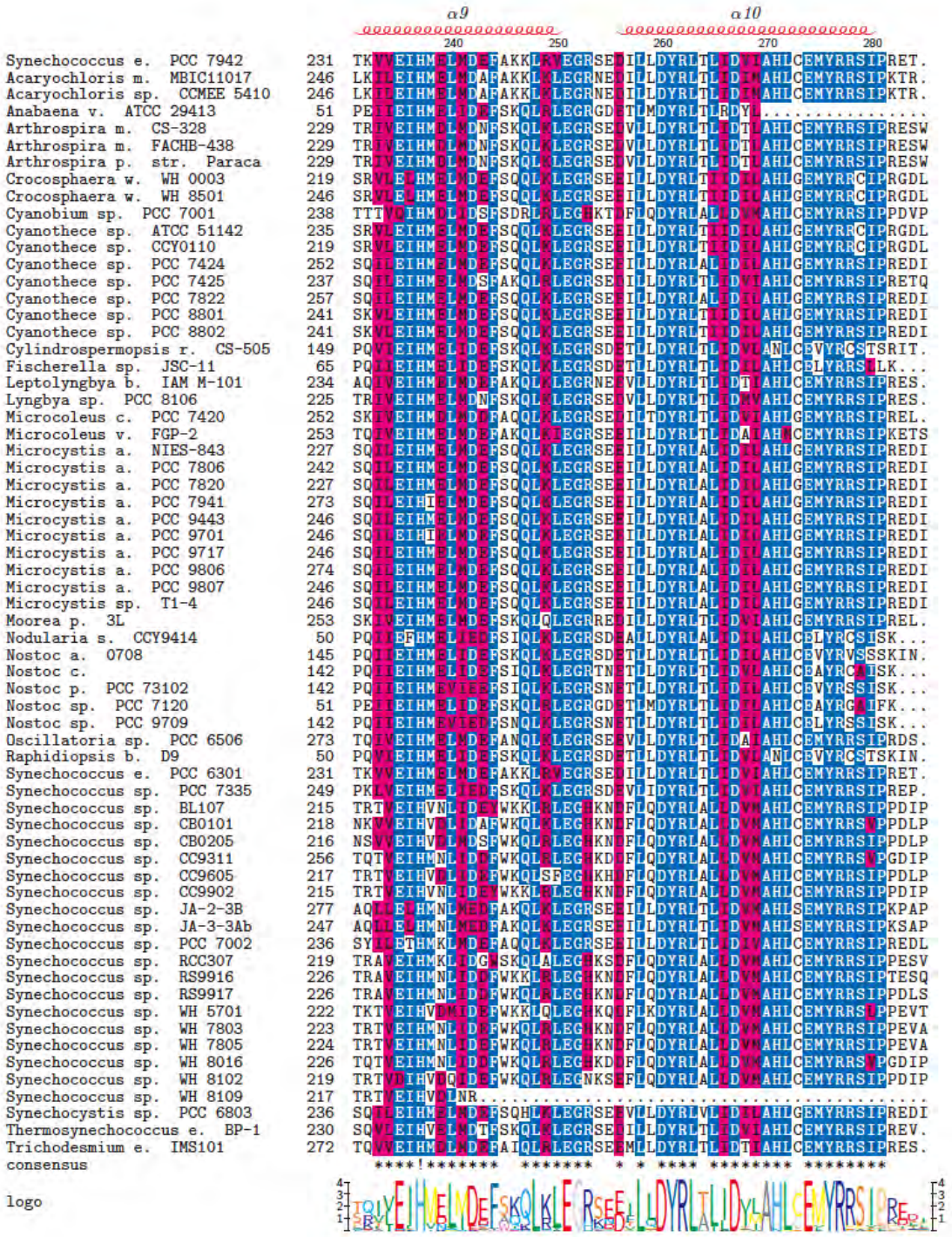
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α10
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Acaryochloris m. MBIC11017 246 LKILEIHMELMDAFAKKLKLEGRNEDILLDYRLTLIDIMAHLCEMYRRSIPKTR.
Acaryochloris sp. CCMEE 5410 246 LKILEIHMELMDAFAKKLKLEGRNEDILLDYRLTLIDIMAHLCEMYRRSIPKTR.
Anabaena v. ATCC 29413 51 PEIIEIHMELIDEFSKQLRLEGRGDETLMDYRLTLRDYL.....
Arthrospira m. CS-328 229 TRIVEIHMELMDNFSKQLKLEGRSEDVLLDYRLTLIDTIAHLCEMYRRSIPRESW
Arthrospira m. FACHB-438 229 TRIVEIHMELMDNFSKQLKLEGRSEDVLLDYRLTLIDTIAHLCEMYRRSIPRESW
Arthrospira p. str. Paraca 229 TRIVEIHMELMDNFSKQLKLEGRSEDVLLDYRLTLIDTIAHLCEMYRRSIPRESW
Crocosphaera w. WH 0003 219 SRVLELHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRCIPRGDL
Crocosphaera w. WH 8501 246 SRVLELHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRCIPRGDL
Cyanobium sp. PCC 7001 238 TTTVQIHMELIDSFSDRLRLEGHKTDFLQDYRLALIDIMAHLCEMYRRSIPPDVP
Cyanothece sp. ATCC 51142 235 SRVLEIHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRCIPRGDL
Cyanothece sp. CCY0110 219 SRVLEIHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRCIPRGDL
Cyanothece sp. PCC 7424 252 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Cyanothece sp. PCC 7425 237 SQILEIHMELMDSFAKQLRLEGRSEDILLDYRLTLIDVIAHLCEMYRRSIPRETQ
Cyanothece sp. PCC 7822 257 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Cyanothece sp. PCC 8801 241 SKVLEIHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRSIPREDI
Cyanothece sp. PCC 8802 241 SKVLEIHMELMDEFSQQLKLEGRSEEILLDYRLTIIDIIAHLGEMYRRSIPREDI
Cylindrospermopsis r. CS-505 149 PQVIEIHMELIDEFSKQLKLEGRSDETLLDYRLTLIDVLANLCEVYRCSTSRIT.
Fischerella sp. JSC-11 65 PQIIEIHMELIDEFSKQLKLEGRSDETLLDYRLTLIDILAHLCELYRRSILK...
Leptolyngbya b. IAM M-101 234 AQIVEIHMELMDEFAKQLKLEGRNEDVLLDYRLTLIDTIAHLCEMYRRSIPRES.
Lyngbya sp. PCC 8106 225 TRIVEIHMELMDNFSKQLKLEGRSEDVLLDYRLTLIDMVAHLCEMYRRSIPRES.
Microcoleus c. PCC 7420 252 SKIVEIHMELMDDFAQQLKLEGRSEDILLTDYRLTLIDVIAHLGEMYRRSIPREL.
Microcoleus v. FGP-2 253 TQIVEIHMELMDEFAKQLKIEGRSEEILLDYRLTLIDAIAHMCEMYRRSIPKETS
Microcystis a. NIES-843 227 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 7806 242 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 7820 227 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 7941 273 SQILEIHILMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 9443 246 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 9701 246 SQILEIHILMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 9717 246 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 9806 274 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis a. PCC 9807 246 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Microcystis sp. T1-4 246 SQILEIHMELMDEFSQQLKLEGRSEEILLDYRLALIDIIAHLGEMYRRSIPREDI
Moorea p. 3L 253 SKIVEIHMELMDEFSKQLQLEGRREDILLDYRLTLIDVIAHLGEMYRRSIPREL.
Nodularia s. CCY9414 50 PQIIEFHMELIEDFSIQLKLEGRSDEALLDYRLALIDIIAHLCELYRCSISK...
Nostoc a. 0708 145 PQIIEIHMELIDEFSKQLKLEGRSDETLLDYRLTLIDIIAHLCEVYRVSSSKIN.
Nostoc c. 142 PQIIEIHMELIDEFSIQLKLEGRTNETLLDYRLTLIDVLAHLCEAYRCAISK...
Nostoc p. PCC 73102 142 PQIIEIHMEVIEEFSIQLKLEGRSNETLLDYRLTLIDILAHLCEVYRSSISK...
Nostoc sp. PCC 7120 51 PEIIEIHMELIDEFSKQLRLEGRGDETLMDYRLTLIDILAHLCEAYRGAIFK...
Nostoc sp. PCC 9709 142 PQIIEIHMEVIEDFSNQLKLEGRSNETLLDYRLTLIDILAHLCELYRSSISK...
Oscillatoria sp. PCC 6506 273 TQIVEIHMELMDEFANQLKLEGRSEEVLLDYRLTLIDAIAHLCEMYRRSIPRDS.
Raphidiopsis b. D9 50 PQVIEIHMELIDEFSKQLKLEGRSDETLLDYRLTLIDVLANLCEVYRCSTSKIN.
Synechococcus e. PCC 6301 231 TKVVEIHMELMDEFAKKLRVEGRSEDILLDYRLTLIDVIAHLCEMYRRSIPRET.
Synechococcus sp. PCC 7335 249 PKLVEIHMELIEDFSKQLKLEGRSDEVLIDYRLTLIDVIAHLCEMYRRSIPREP.
Synechococcus sp. BL107 215 TRTVEIHVNLIDEYWKKLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPPDIP
Synechococcus sp. CB0101 218 NKVVEIHVELIDAFWKQLKLEGHKNDFLQDYRLALIDVMAHLCEMYRRSVPPDLP
Synechococcus sp. CB0205 216 NSVVEIHVELWDSFWKQLRLEGHKNDFLQDYRLALIDVMAHLCEMYRRSIPPDLP
Synechococcus sp. CC9311 256 TQTVEIHLNLIDEFWKQLRLEGHKDDFLQDYRLALLDVMAHLCEMYRRSVPGDIP
Synechococcus sp. CC9605 217 TRTVEIHVELIDEFWKQLSFEGHKHDFLQDYRLALIDVMAHLCEMYRRSIPPDLP
Synechococcus sp. CC9902 215 TRTVEIHVNLIDEYWKKLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPPDIP
Synechococcus sp. JA-2-3B 277 AQLLELHMNLMEDFAKQLKLEGRSEEILLDYRLTLIDVMAHLSEMYRRSIPKPAP
Synechococcus sp. JA-3-3Ab 247 AQLLELHMNLMEDFAKQLKLEGRSEEILLDYRLTLIDVMAHLSEMYRRSIPKSAP
Synechococcus sp. PCC 7002 236 SYLLETHMKLMDEFAQQLKLEGRSEEILLDYRLTLIDIVAHLCEMYRRSIPREDL
Synechococcus sp. RCC307 219 TRAVEIHMKLIDGWSKQLALEGHKSDFLQDYRLALLDVMAHLCEMYRRSIPPESV
Synechococcus sp. RS9916 226 TRAVEIHLNLIDDFWKKLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPTESQ
Synechococcus sp. RS9917 226 TRAVEIHLNLIDDFWKQLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPPDLS
Synechococcus sp. WH 5701 222 TKTVEIHVDMIDEFWKKLQLEGHKQDFLKDYRLALIDVMAHLCEMYRRSLPPEVT
Synechococcus sp. WH 7803 223 TRTVEIHLNLIDEFWKQLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPPEVA
Synechococcus sp. WH 7805 224 TRTVEIHMNLIDEFWKQLRLEGHKNDFLQDYRLALLDVMAHLCEMYRRSIPPEVA
Synechococcus sp. WH 8016 226 TQTVEIHLNLIDDFWKQLRLEGHKDDFLQDYRLALIDVMAHLCEMYRRSVPGDIP
Synechococcus sp. WH 8102 219 TRTVDIHVDQIDEFWKQLRLEGNKSEFLQDYRLALLDVMAHLCEMYRRSIPPDIP
Synechococcus sp. WH 8109 217 TRTVEIHVDLNR.....
Synechocystis sp. PCC 6803 236 SQILEIHMELMDEFSQHLKLEGRSEEVLLDYRLVLIDIIAHLGEMYRRSIPREDI
Thermosynechococcus e. BP-1 230 SQVLEIHVELMDTFSKQLKLEGRSEDILLDYRLTLIDVIAHLCEMYRRSIPREV.
Trichodesmium e. IMS101 272 TQVVEIHMELMDEFAIQLRLEGRSEEMLLDYRLTLIDTIAHLCEMYRRSIPRES.
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Synechococcus e.  PCC 7942          285  .........................
Acaryochloris m.  MBIC11017         300  .........................
Acaryochloris sp.  CCMEE 5410       300  .........................
Anabaena v.  ATCC 29413              90  .........................
Arthrospira m.  CS-328              284  GE.......................
Arthrospira m.  FACHB-438           284  GE.......................
Arthrospira p.  str.  Paraca        284  GE.......................
Crocosphaera w.  WH 0003            274  LFDLLNQMD................
Crocosphaera w.  WH 8501            301  LFDLLNQMD................
Cyanobium sp.  PCC 7001             293  LIRFSAST.................
Cyanothece sp.  ATCC 51142          290  LFDLLNQID................
Cyanothece sp.  CCY0110             274  LFDLLNQID................
Cyanothece sp.  PCC 7424            307  PYELLFRID................
Cyanothece sp.  PCC 7425            292  SRET.....................
Cyanothece sp.  PCC 7822            312  PYELLFRID................
Cyanothece sp.  PCC 8801            296  LFDLLYQID................
Cyanothece sp.  PCC 8802            296  LFDLLYQID................
Cylindrospermopsis r.  CS-505       203  .........................
Fischerella sp.  JSC-11             117  .........................
Leptolyngbya b.  IAM M-101          288  .........................
Lyngbya sp.  PCC 8106               279  .........................
Microcoleus c.  PCC 7420            306  .........................
Microcoleus v.  FGP-2               308  QGRM.....................
Microcystis a.  NIES-843            282  PYDLLLGID................
Microcystis a.  PCC 7806            297  PYDLLLGID................
Microcystis a.  PCC 7820            282  PYDLLLGID................
Microcystis a.  PCC 7941            328  PYDLSQMSG................
Microcystis a.  PCC 9443            301  PYDLLLGID................
Microcystis a.  PCC 9701            301  PYDLLLGID................
Microcystis a.  PCC 9717            301  PYDLLLGID................
Microcystis a.  PCC 9806            329  PYDLSQMSG................
Microcystis a.  PCC 9807            301  PYDLLLGID................
Microcystis sp.  T1-4               301  PDDLSQMSG................
Moorea p.  3L                       307  .........................
Nodularia s.  CCY9414               102  .........................
Nostoc a.  0708                     199  .........................
Nostoc c.                           194  .........................
Nostoc p.  PCC 73102                194  .........................
Nostoc sp.  PCC 7120                103  .........................
Nostoc sp.  PCC 9709                194  .........................
Oscillatoria sp.  PCC 6506          327  .........................
Raphidiopsis b.  D9                 104  .........................
Synechococcus e.  PCC 6301          285  .........................
Synechococcus sp.  PCC 7335         303  .........................
Synechococcus sp.  BL107            270  LPGEASNRPSVAVDQPMSSEELL
Synechococcus sp.  CB0101           273  LGAPQDPEEASQSPSQEVI....
Synechococcus sp.  CB0205           271  LAEPPPGESVG..............
Synechococcus sp.  CC9311           311  LVPAGSQRRQLQNSEVSL......
Synechococcus sp.  CC9605           272  LSGTASSRVRRPMDQLDASEESS
Synechococcus sp.  CC9902           270  LPSEASNRLSVAVDQPMSSEELL
Synechococcus sp.  JA-2-3B          332  RDP......................
Synechococcus sp.  JA-3-3Ab         302  RDP......................
Synechococcus sp.  PCC 7002         291  PFELLFRID................
Synechococcus sp.  RCC307           274  GAGARASAGSAVAQQEESPS.....
Synechococcus sp.  RS9916           281  LARSEQFGEEVVSS...........
Synechococcus sp.  RS9917           281  LSASVASQPAGASAVTDQELSS..
Synechococcus sp.  WH 5701          277  DKPSEGMVAKIITASQVQS......
Synechococcus sp.  WH 7803          278  LAVPSEQRRSLMDSEVSS.......
Synechococcus sp.  WH 7805          279  LATSAEYRQALMDSQVSP.......
Synechococcus sp.  WH 8016          281  LVPSGSQRRQLQDSEVTL......
Synechococcus sp.  WH 8102          274  LSGLASGRHRREADLPDAPEVSS
Synechococcus sp.  WH 8109          229  .........................
Synechocystis sp.  PCC 6803         291  PFDVYYQTD................
Thermosynechococcus e.  BP-1        284  .........................
Trichodesmium e.  IMS101            326  .........................
consensus

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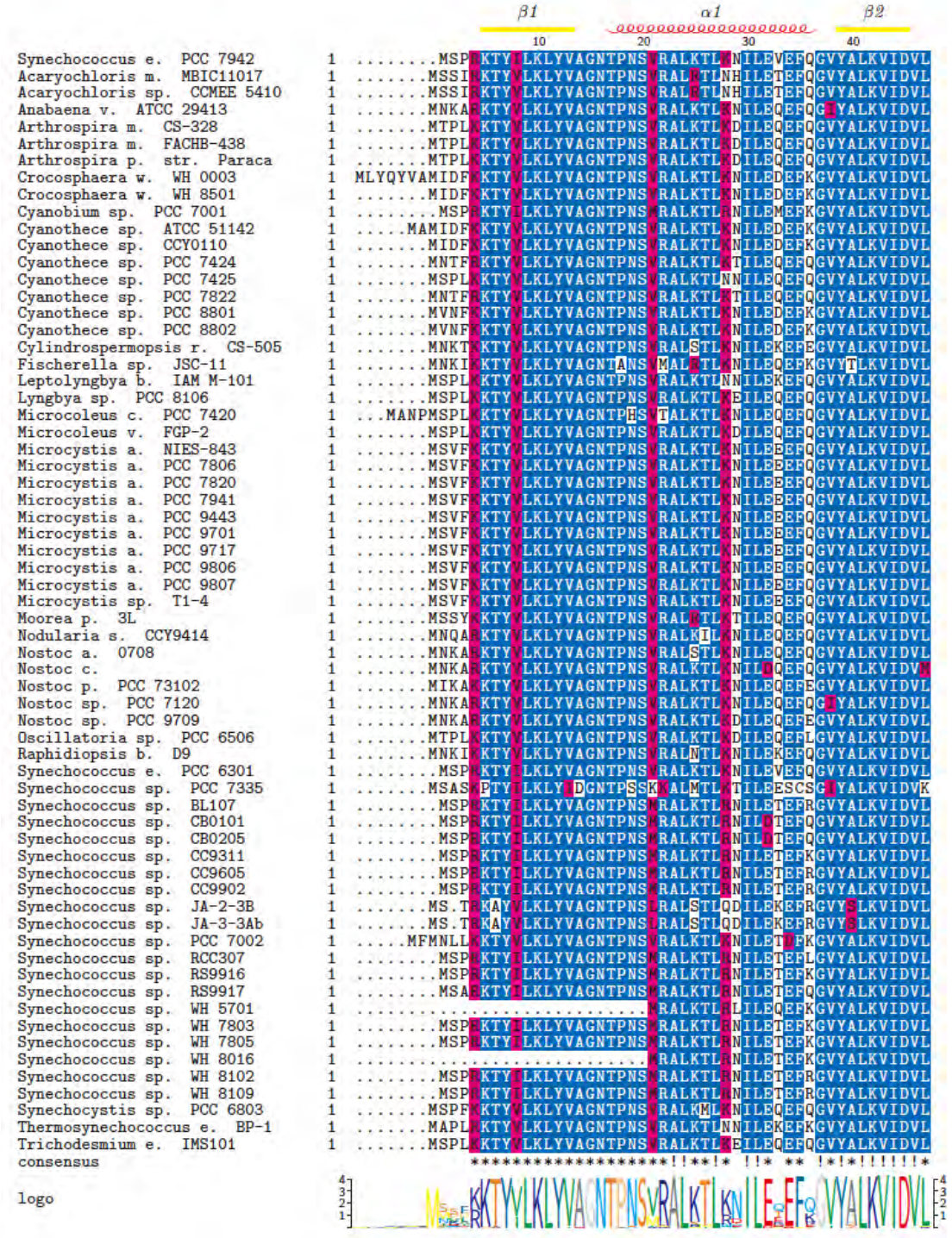
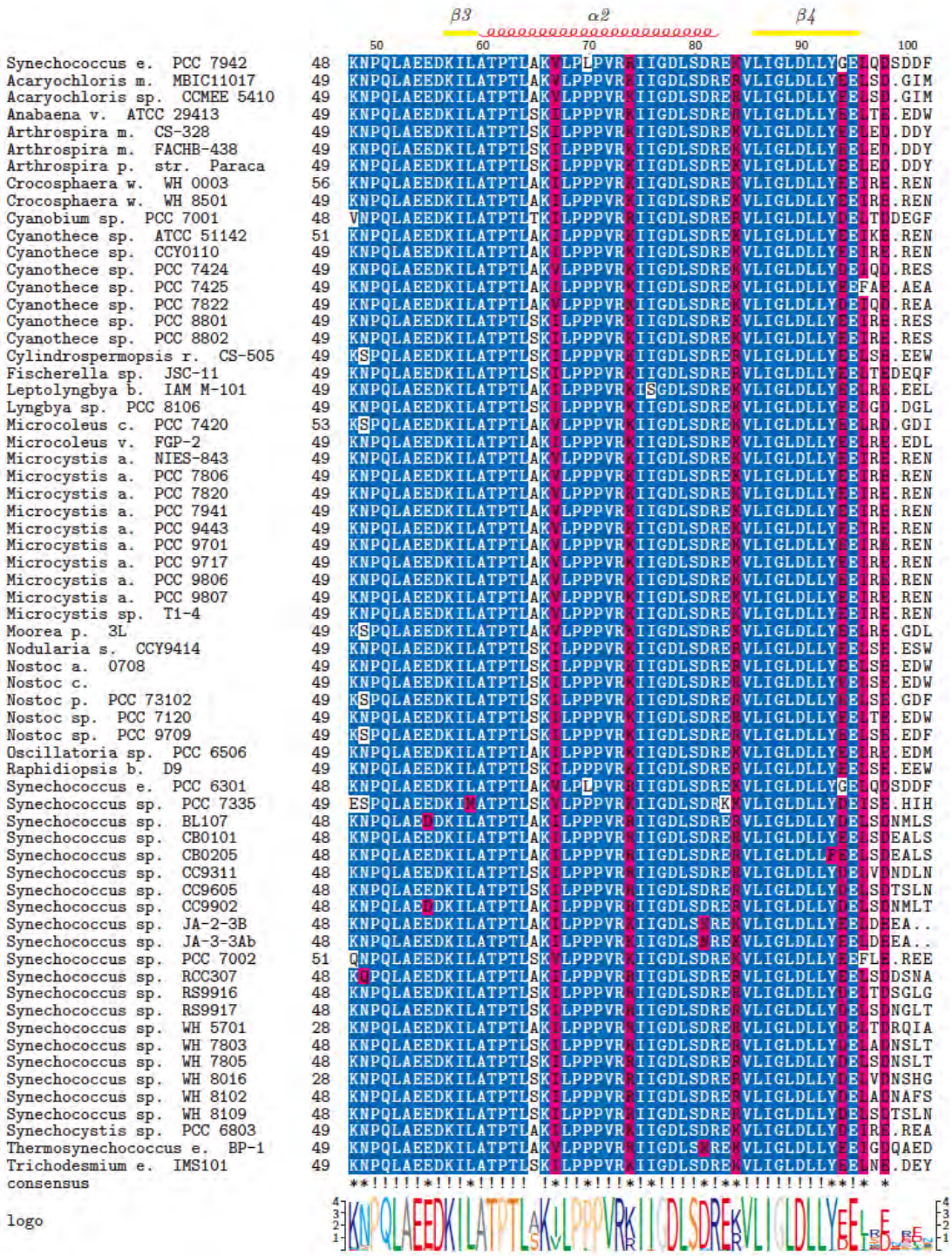

β1
α1
β2
10
20
30
40
Synechococcus e. PCC 7942
Acaryochloris m. MBIC11017
Acaryochloris sp. CCMEE 5410
Anabaena v. ATCC 29413
Arthrospira m. CS-328
Arthrospira m. FACHB-438
Arthrospira p. str. Paraca
Crocosphaera w. WH 0003
Crocosphaera w. WH 8501
Cyanobium sp. PCC 7001
Cyanothece sp. ATCC 51142
Cyanothece sp. CCY0110
Cyanothece sp. PCC 7424
Cyanothece sp. PCC 7425
Cyanothece sp. PCC 7822
Cyanothece sp. PCC 8801
Cyanothece sp. PCC 8802
Cylindrospermopsis r. CS-505
Fischerella sp. JSC-11
Leptolyngbya b. IAM M-101
Lyngbya sp. PCC 8106
Microcoleus c. PCC 7420
Microcoleus v. FGP-2
Microcystis a. NIES-843
Microcystis a. PCC 7806
Microcystis a. PCC 7820
Microcystis a. PCC 7941
Microcystis a. PCC 9443
Microcystis a. PCC 9701
Microcystis a. PCC 9717
Microcystis a. PCC 9806
Microcystis a. PCC 9807
Microcystis sp. T1-4
Moorea p. 3L
Nodularia s. CCY9414
Nostoc a. 0708
Nostoc c.
Nostoc p. PCC 73102
Nostoc sp. PCC 7120
Nostoc sp. PCC 9709
Oscillatoria sp. PCC 6506
Raphidiopsis b. D9
Synechococcus e. PCC 6301
Synechococcus sp. PCC 7335
Synechococcus sp. BL107
Synechococcus sp. CB0101
Synechococcus sp. CB0205
Synechococcus sp. CC9311
Synechococcus sp. CC9605
Synechococcus sp. CC9902
Synechococcus sp. JA-2-3B
Synechococcus sp. JA-3-3Ab
Synechococcus sp. PCC 7002
Synechococcus sp. RCC307
Synechococcus sp. RS9916
Synechococcus sp. RS9917
Synechococcus sp. WH 5701
Synechococcus sp. WH 7803
Synechococcus sp. WH 7805
Synechococcus sp. WH 8016
Synechococcus sp. WH 8102
Synechococcus sp. WH 8109
Synechocystis sp. PCC 6803
Thermosynechococcus e. BP-1
Trichodesmium e. IMS101
consensus
logo


β3
α2
β4
50
60
70
80
90
100
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Acaryochloris m. MBIC11017 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEELSD.GIM
Acaryochloris sp. CCMEE 5410 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEELSD.GIM
Anabaena v. ATCC 29413 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELTE.EDW
Arthrospira m. CS-328 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELED.DDY
Arthrospira m. FACHB-438 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELED.DDY
Arthrospira p. str. Paraca 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELED.DDY
Crocosphaera w. WH 0003 56 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Crocosphaera w. WH 8501 49 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Cyanobium sp. PCC 7001 48 VNPQLAEEDKILATPTLTKILPPPVRRIIGDLSDREKVLIGLDLLYEELTDEGF
Cyanothece sp. ATCC 51142 51 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEIKE.REN
Cyanothece sp. CCY0110 49 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Cyanothece sp. PCC 7424 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIQD.RES
Cyanothece sp. PCC 7425 49 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEFAE.AEA
Cyanothece sp. PCC 7822 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEETQD.REA
Cyanothece sp. PCC 8801 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.RES
Cyanothece sp. PCC 8802 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.RES
Cylindrospermopsis r. CS-505 49 KSPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.EEW
Fischerella sp. JSC-11 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELTEDEQF
Leptolyngbya b. IAM M-101 49 KNPQLAEEDKILATPTLAKILPPPVRKISGDLSDREKVLIGLDLLYEELRE.EEL
Lyngbya sp. PCC 8106 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELGD.DGL
Microcoleus c. PCC 7420 53 KSPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEELRD.GDI
Microcoleus v. FGP-2 49 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEELRE.EDL
Microcystis a. NIES-843 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 7806 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 7820 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 7941 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 9443 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 9701 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 9717 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 9806 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis a. PCC 9807 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Microcystis sp. T1-4 49 KNPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.REN
Moorea p. 3L 49 KSPQLAEEDKILATPTLAKVLPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.GDL
Nodularia s. CCY9414 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.ESW
Nostoc a. 0708 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.EDW
Nostoc c. 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.EDW
Nostoc p. PCC 73102 49 KSPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.GDF
Nostoc sp. PCC 7120 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELTE.EDW
Nostoc sp. PCC 9709 49 KSPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.EDF
Oscillatoria sp. PCC 6506 49 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSDREKVLIGLDLLYEEIRE.EDM
Raphidiopsis b. D9 49 KNPQLAEEDKILATPTLSKILPPPVRKIIGDLSDREKVLIGLDLLYEELSE.EEW
Synechococcus e. PCC 6301 48 KNPQLAEEDKILATPTLAKVLPLPVRRIIGDLSDREKVLIGLDLLYGELQDSDDF
Synechococcus sp. PCC 7335 49 ESPQLAEEDKIMATPTLSKVLPPPVRKIIGDLSDRKKVLIGLDLLYDEISE.HIH
Synechococcus sp. BL107 48 KNPQLAEDDKILATPTLAKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDNMLS
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Synechococcus sp. CC9311 48 KNPQLAEEDKILATPTLSKILPPPVRNIIGDLSDREKVLIGLDLLYDELVDNDLN
Synechococcus sp. CC9605 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDTSLN
Synechococcus sp. CC9902 48 KNPQLAEDDKILATPTLAKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDNMLT
Synechococcus sp. JA-2-3B 48 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSWREKVLIGLDLLYDELDEEA..
Synechococcus sp. JA-3-3Ab 48 KNPQLAEEDKILATPTLAKILPPPVRKIIGDLSWREKVLIGLDLLYDELDEEA..
Synechococcus sp. PCC 7002 51 QNPQLAEEDKILATPTLSKVLPPPVRKIIGDLSDREKVLIGLDLLYEEFLE.REE
Synechococcus sp. RCC307 48 KQPQLAEEDKILATPTLAKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDDSNA
Synechococcus sp. RS9916 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELTDSGLG
Synechococcus sp. RS9917 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDNGLT
Synechococcus sp. WH 5701 28 KNPQLAEEDKILATPTLAKILPPPVRNIIGDLSDREKVLIGLDLLYEELTDRQIA
Synechococcus sp. WH 7803 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELADNSLT
Synechococcus sp. WH 7805 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDNSLT
Synechococcus sp. WH 8016 28 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELVDNSHG
Synechococcus sp. WH 8102 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELADNAFS
Synechococcus sp. WH 8109 48 KNPQLAEEDKILATPTLSKILPPPVRRIIGDLSDREKVLIGLDLLYEELSDTSLN
Synechocystis sp. PCC 6803 49 KNPQLAEEDKILATPTLAKILPPPVRNIIGDLSDREKVLIGLDLLYEEIRE.REA
Thermosynechococcus e. BP-1 49 KNPQLAEEDKILATPTLAKVLPPPVRNIIGDLSWREKVLIGLDLLYEEIGDQAED
Trichodesmium e. IMS101 49 KNPQLAEEDKILATPTLSKILPPPVRAIIGDLSDREKVLIGLDLLYEELNE.DEY
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Synechococcus e.  PCC 7942      103  ................................
Acaryochloris m.  MBIC11017     103  EY..............................
Acaryochloris sp.  CCMEE 5410   103  EY..............................
Anabaena v.  ATCC 29413         103  EAQSSL..........................
Arthrospira m.  CS-328          103  NF..............................
Arthrospira m.  FACHB-438       103  NF..............................
Arthrospira p.  str.  Paraca    103  NF..............................
Crocosphaera w.  WH 0003        110  DP..............................
Crocosphaera w.  WH 8501        103  DP..............................
Cyanobium sp.  PCC 7001         103  DALPLASPASEPDASLPAVPSEGARSVDGLNPPA
Cyanothece sp.  ATCC 51142      105  DP..............................
Cyanothece sp.  CCY0110         103  DP..............................
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Cyanothece sp.  PCC 7425        103  EAE.............................
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Cyanothece sp.  PCC 8802        103  EL..............................
Cylindrospermopsis r.  CS-505   103  DNIDDHKIEEIN....................
Fischerella sp.  JSC-11         104  QTE.............................
Leptolyngbya b.  IAM M-101      103  DSQ.............................
Lyngbya sp.  PCC 8106           103  NL..............................
Microcoleus c.  PCC 7420        107  DF..............................
Microcoleus v.  FGP-2           103  NS..............................
Microcystis a.  NIES-843        103  DS..............................
Microcystis a.  PCC 7806        103  DS..............................
Microcystis a.  PCC 7820        103  DS..............................
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Microcystis a.  PCC 9806        103  DS..............................
Microcystis a.  PCC 9807        103  DS..............................
Microcystis sp.  T1-4           103  DS..............................
Moorea p.  3L                   103  DF..............................
Nodularia s.  CCY9414           103  EE..............................
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Nostoc c.                       103  EESHNL..........................
Nostoc p.  PCC 73102            103  EE..............................
Nostoc sp.  PCC 7120            103  EAQSNL..........................
Nostoc sp.  PCC 9709            103  E...............................
Oscillatoria sp.  PCC 6506      103  NLHDRI..........................
Raphidiopsis b.  D9             103  DNIDDHKIEEIN....................
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Synechococcus sp.  PCC 7335     103  N...............................
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Synechococcus sp.  WH 5701       83  DEMMD..ESDEI....................
Synechococcus sp.  WH 7803      103  STLMDALEDADTTDSDS...............
Synechococcus sp.  WH 7805      103  STLMDALEDADTTDSDS...............
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Synechococcus sp.  WH 8109      103  SSLIDAVDEETDTTISSDP.............
Synechocystis sp.  PCC 6803     103  EDQ.............................
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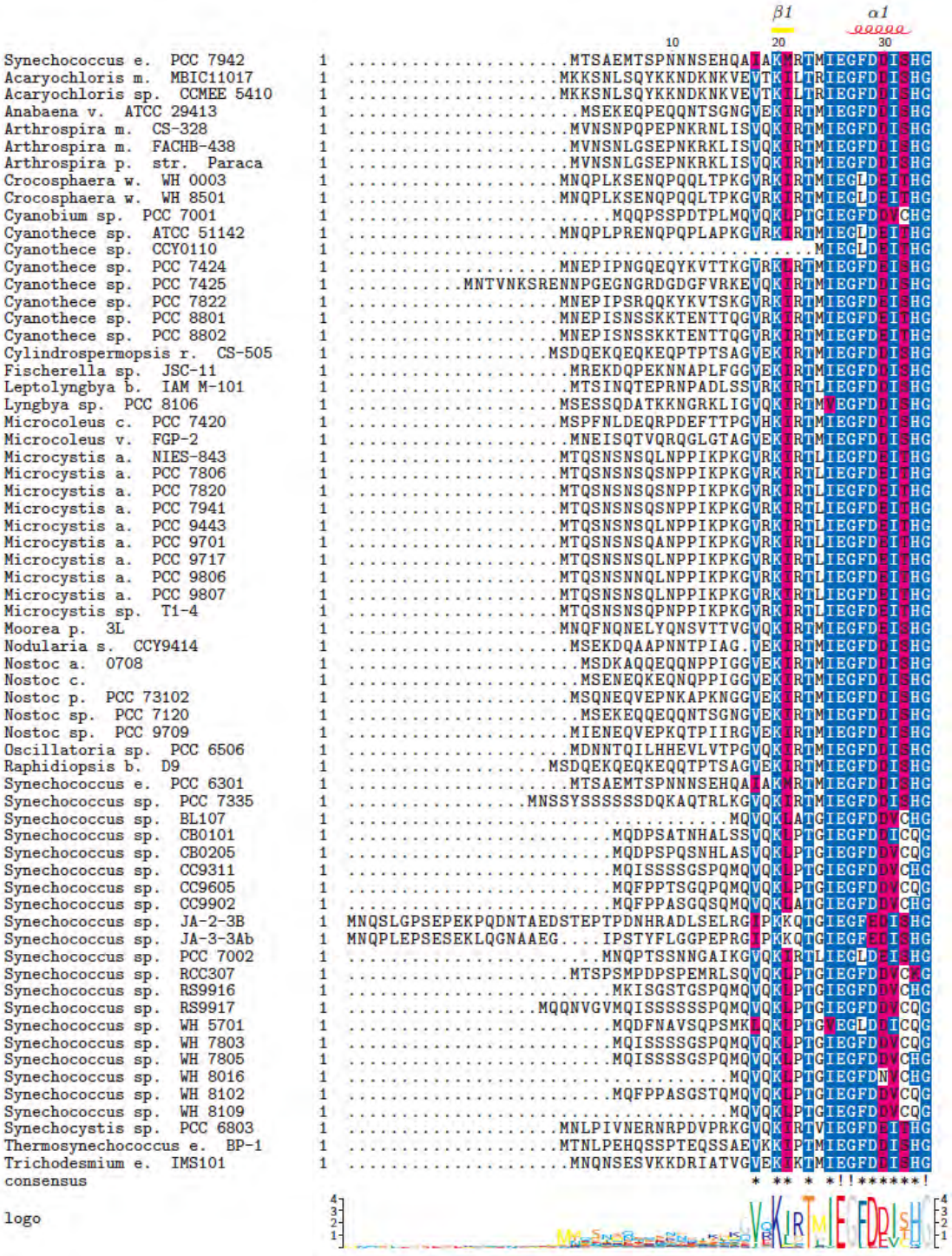
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Arthrospira m. CS-328
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Arthrospira p. str. Paraca
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Cyanothece sp. PCC 8801
Cyanothece sp. PCC 8802
Cylindrospermopsis r. CS-505
Fischerella sp. JSC-11
Leptolyngbya b. IAM M-101
Lyngbya sp. PCC 8106
Microcoleus c. PCC 7420
Microcoleus v. FGP-2
Microcystis a. NIES-843
Microcystis a. PCC 7806
Microcystis a. PCC 7820
Microcystis a. PCC 7941
Microcystis a. PCC 9443
Microcystis a. PCC 9701
Microcystis a. PCC 9717
Microcystis a. PCC 9806
Microcystis a. PCC 9807
Microcystis sp. T1-4
Moorea p. 3L
Nodularia s. CCY9414
Nostoc a. 0708
Nostoc c.
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Nostoc sp. PCC 7120
Nostoc sp. PCC 9709
Oscillatoria sp. PCC 6506
Raphidiopsis b. D9
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Synechococcus sp. PCC 7335
Synechococcus sp. BL107
Synechococcus sp. CB0101
Synechococcus sp. CB0205
Synechococcus sp. CC9311
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Synechococcus sp. JA-2-3B
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Synechococcus sp. PCC 7002
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Synechococcus sp. RS9917
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Trichodesmium e. IMS101
consensus
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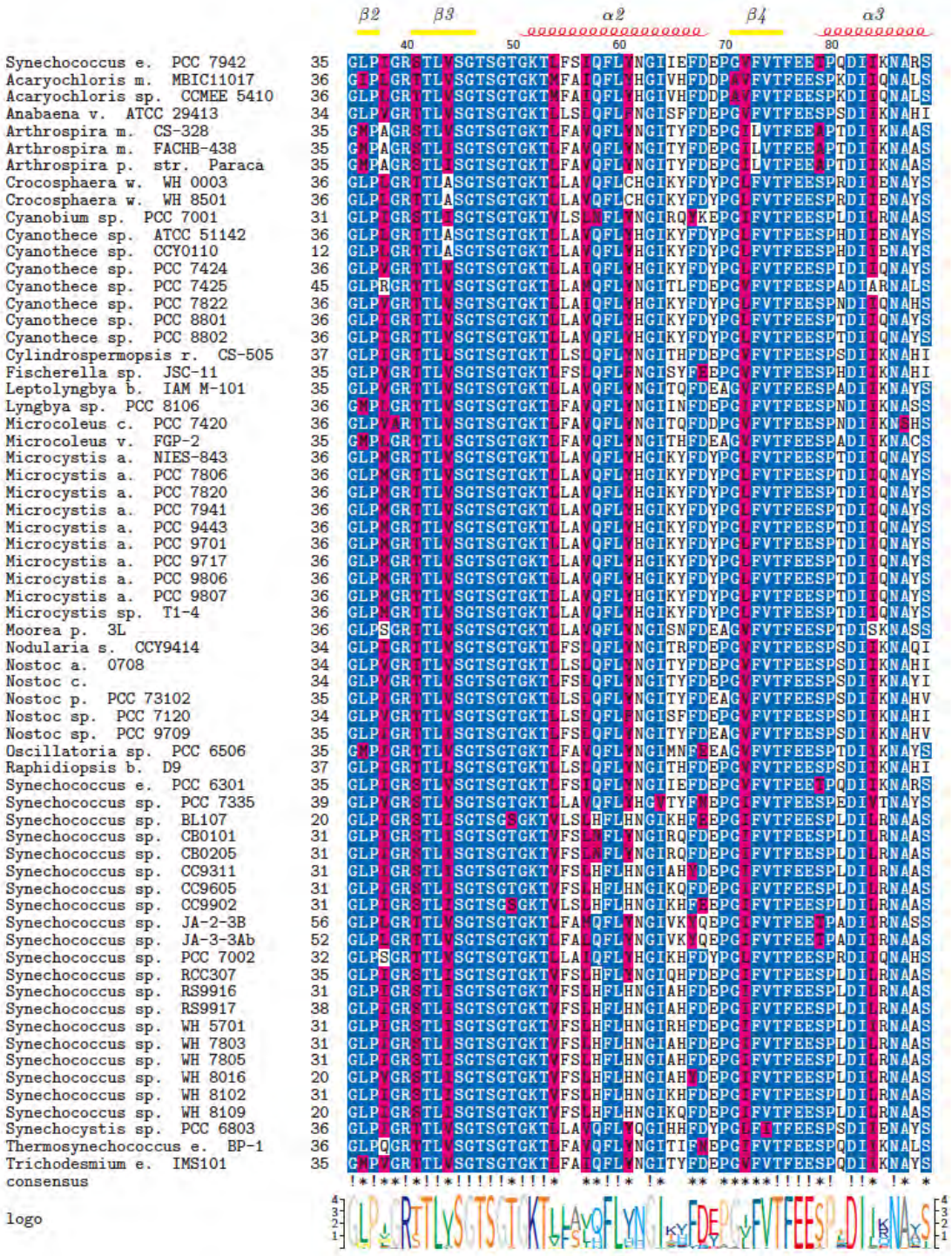
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Cyanothece sp. PCC 8801 36
Cyanothece sp. PCC 8802 36
Cylindrospermopsis r. CS-505 37
Fischerella sp. JSC-11 35
Leptolyngbya b. IAM M-101 35
Lyngbya sp. PCC 8106 36
Microcoleus c. PCC 7420 36
Microcoleus v. FGP-2 35
Microcystis a. NIES-843 36
Microcystis a. PCC 7806 36
Microcystis a. PCC 7820 36
Microcystis a. PCC 7941 36
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Microcystis sp. T1-4 36
Moorea p. 3L 36
Nodularia s. CCY9414 34
Nostoc a. 0708 34
Nostoc c. 34
Nostoc p. PCC 73102 35
Nostoc sp. PCC 7120 34
Nostoc sp. PCC 9709 35
Oscillatoria sp. PCC 6506 35
Raphidiopsis b. D9 37
Synechococcus e. PCC 6301 35
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Synechococcus sp. BL107 20
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Synechococcus sp. PCC 7002 32
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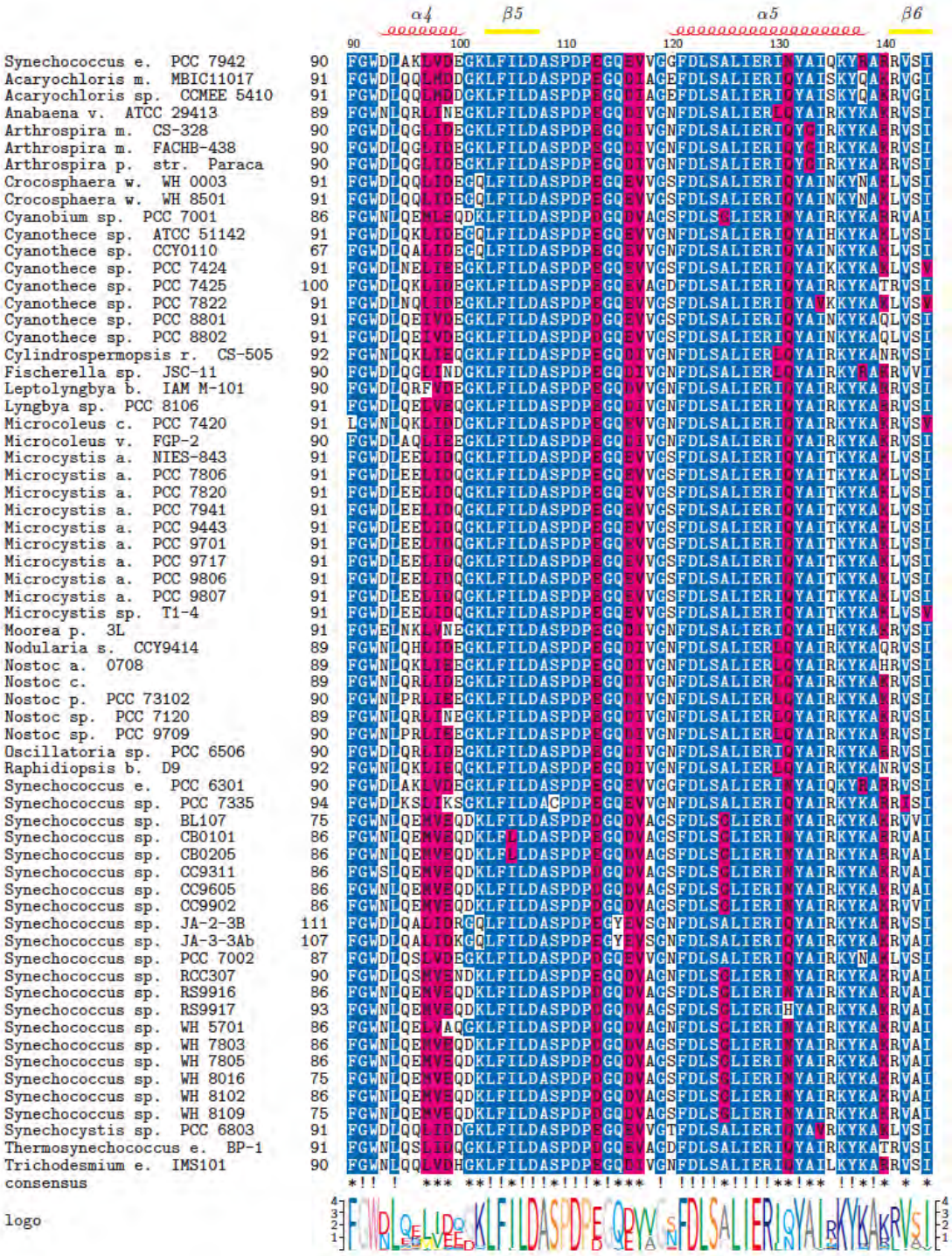
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Cyanothece sp. PCC 8802 91
Cylindrospermopsis r. CS-505 92
Fischerella sp. JSC-11 90
Leptolyngbya b. IAM M-101 90
Lyngbya sp. PCC 8106 91
Microcoleus c. PCC 7420 91
Microcoleus v. FGP-2 90
Microcystis a. NIES-843 91
Microcystis a. PCC 7806 91
Microcystis a. PCC 7820 91
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Moorea p. 3L 91
Nodularia s. CCY9414 89
Nostoc a. 0708 89
Nostoc c. 89
Nostoc p. PCC 73102 90
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Synechococcus e. PCC 6301 90
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Synechococcus sp. JA-3-3Ab 107
Synechococcus sp. PCC 7002 87
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Synechococcus sp. WH 7803 86
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consensus
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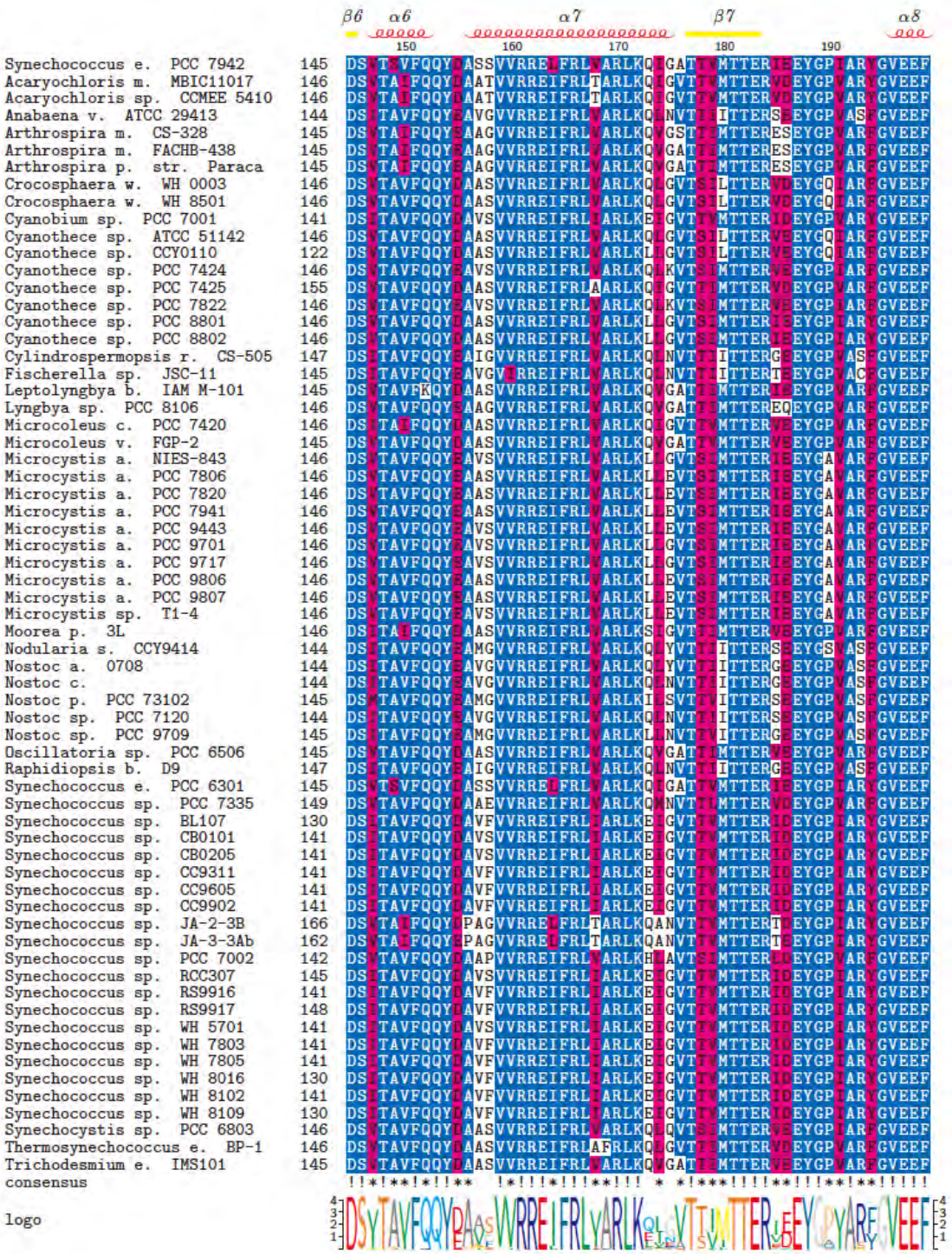
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α8
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Anabaena v. ATCC 29413 144
Arthrospira m. CS-328 145
Arthrospira m. FACHB-438 145
Arthrospira p. str. Paraca 145
Crocosphaera w. WH 0003 146
Crocosphaera w. WH 8501 146
Cyanobium sp. PCC 7001 141
Cyanothece sp. ATCC 51142 146
Cyanothece sp. CCY0110 122
Cyanothece sp. PCC 7424 146
Cyanothece sp. PCC 7425 155
Cyanothece sp. PCC 7822 146
Cyanothece sp. PCC 8801 146
Cyanothece sp. PCC 8802 146
Cylindrospermopsis r. CS-505 147
Fischerella sp. JSC-11 145
Leptolyngbya b. IAM M-101 145
Lyngbya sp. PCC 8106 146
Microcoleus c. PCC 7420 146
Microcoleus v. FGP-2 145
Microcystis a. NIES-843 146
Microcystis a. PCC 7806 146
Microcystis a. PCC 7820 146
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Microcystis sp. T1-4 146
Moorea p. 3L 146
Nodularia s. CCY9414 144
Nostoc a. 0708 144
Nostoc c. 144
Nostoc p. PCC 73102 145
Nostoc sp. PCC 7120 144
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Oscillatoria sp. PCC 6506 145
Raphidiopsis b. D9 147
Synechococcus e. PCC 6301 145
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Synechococcus sp. BL107 130
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Synechococcus sp. JA-2-3B 166
Synechococcus sp. JA-3-3Ab 162
Synechococcus sp. PCC 7002 142
Synechococcus sp. RCC307 145
Synechococcus sp. RS9916 141
Synechococcus sp. RS9917 148
Synechococcus sp. WH 5701 141
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Synechocystis sp. PCC 6803 146
Thermosynechococcus e. BP-1 146
Trichodesmium e. IMS101 145
consensus
logo


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β8
β9
β10
β11
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210
220
230
240
250
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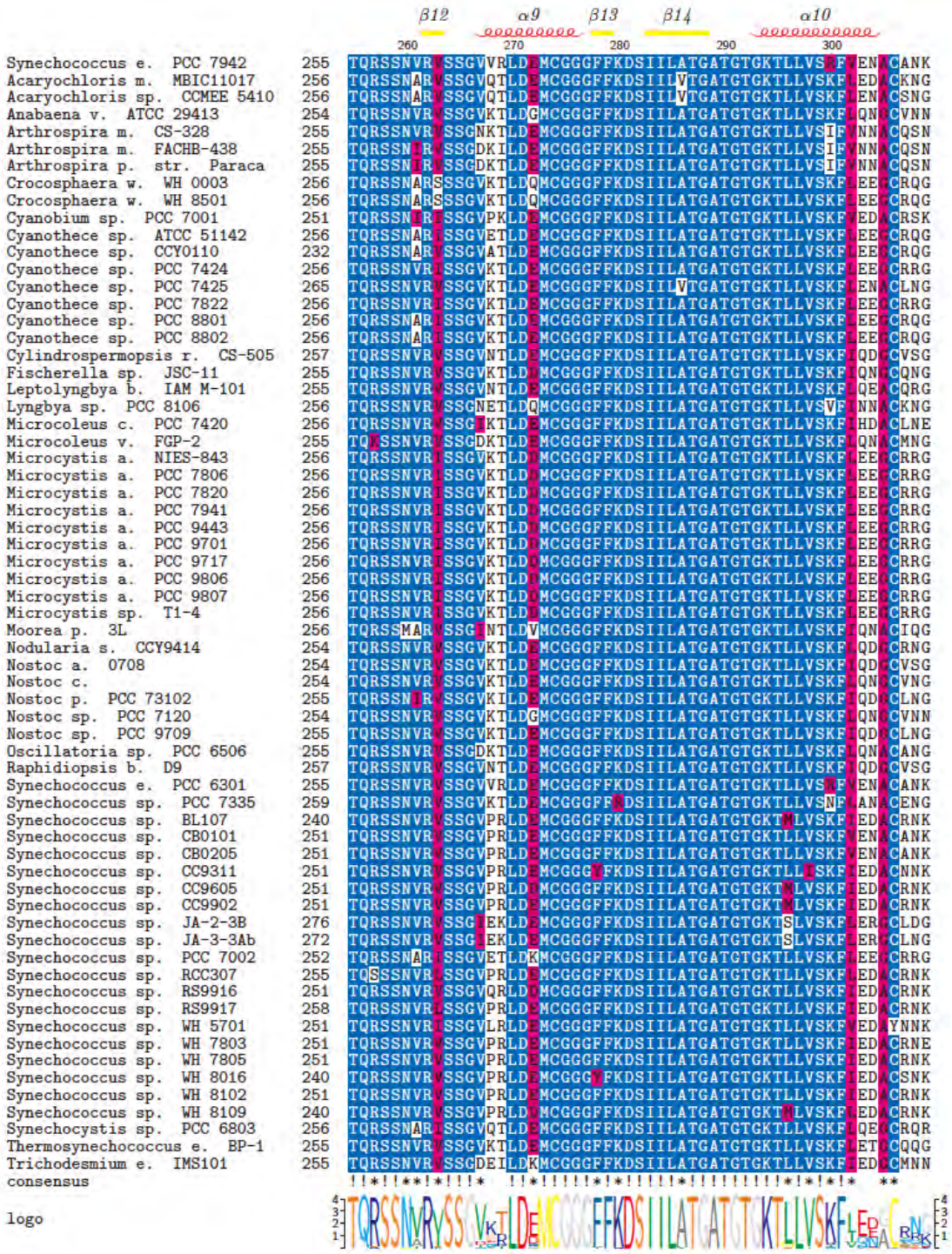
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Cyanothece sp. PCC 8802 256 TQRSSNARISSGVKTLDEMCGGGFFKDSIILATGATGTGKTLLVSKFLEETCRQG
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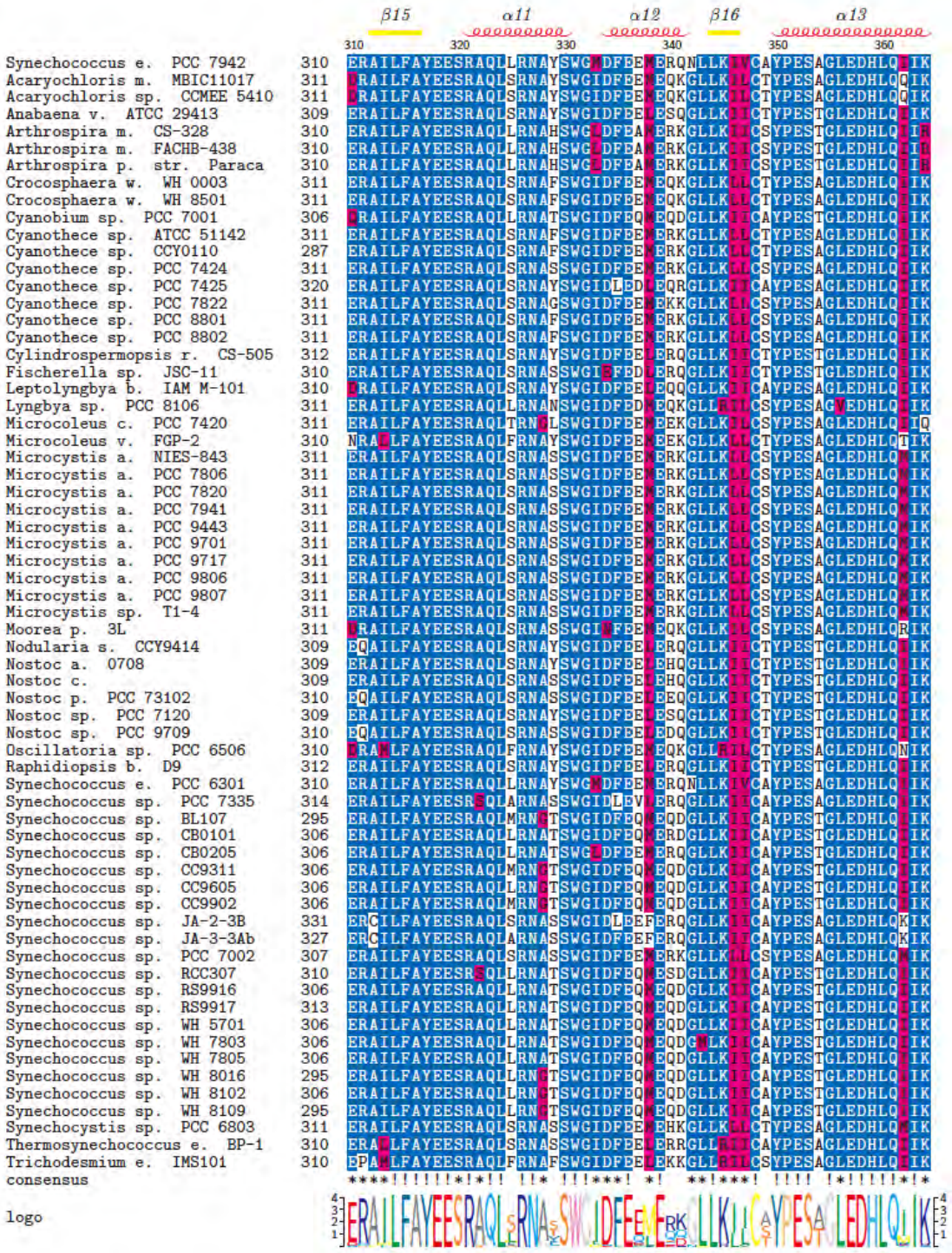
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β16
α13
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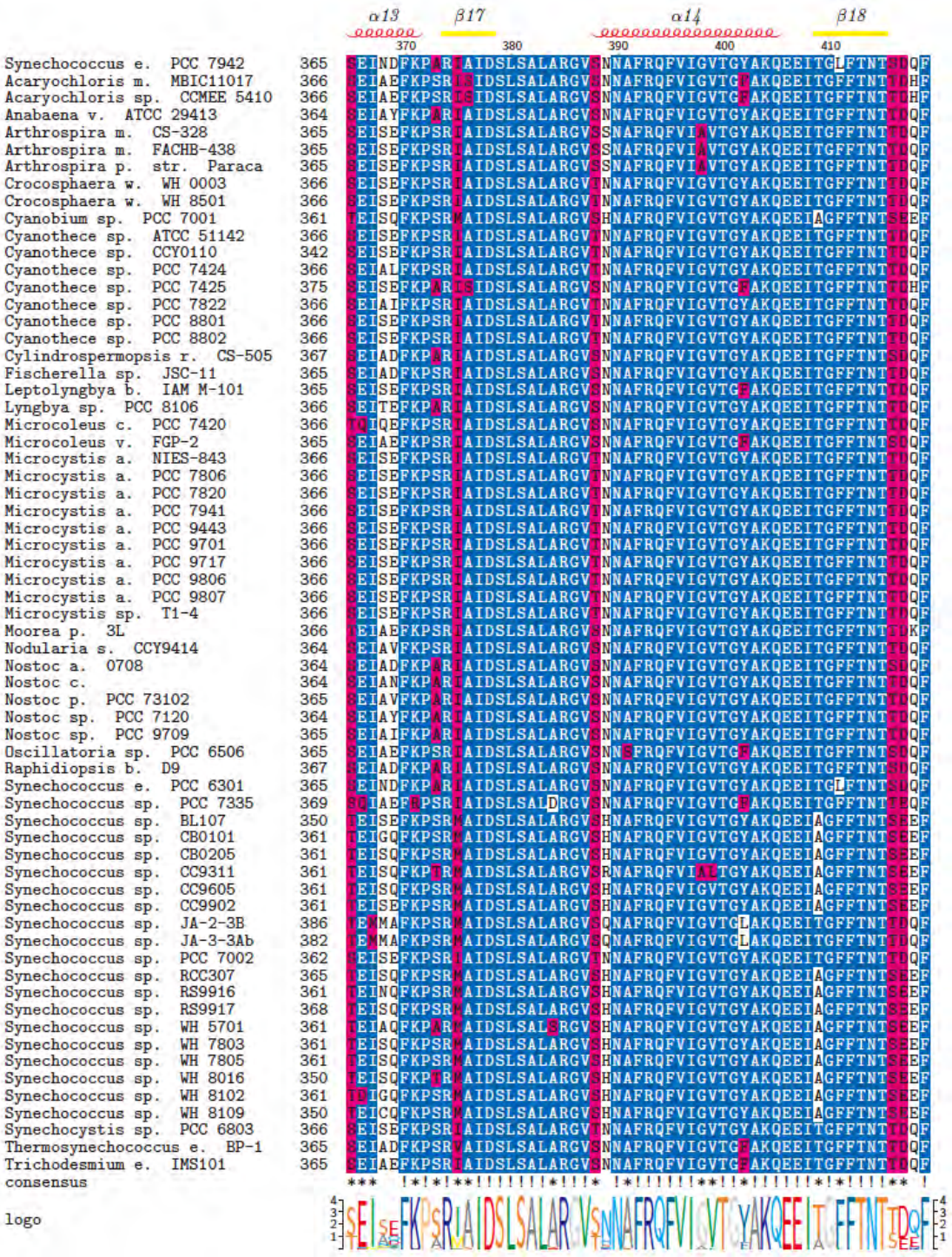
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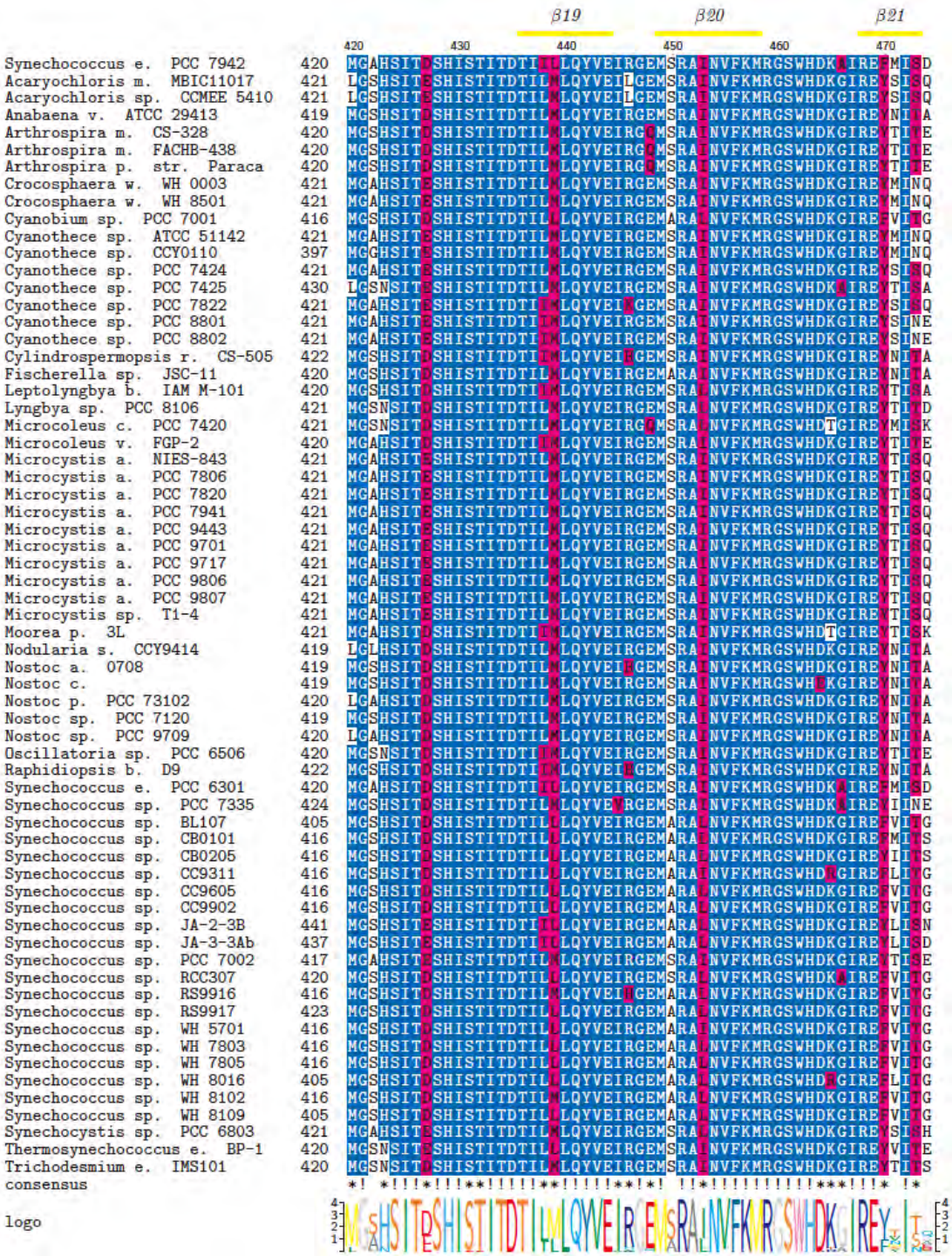
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β21
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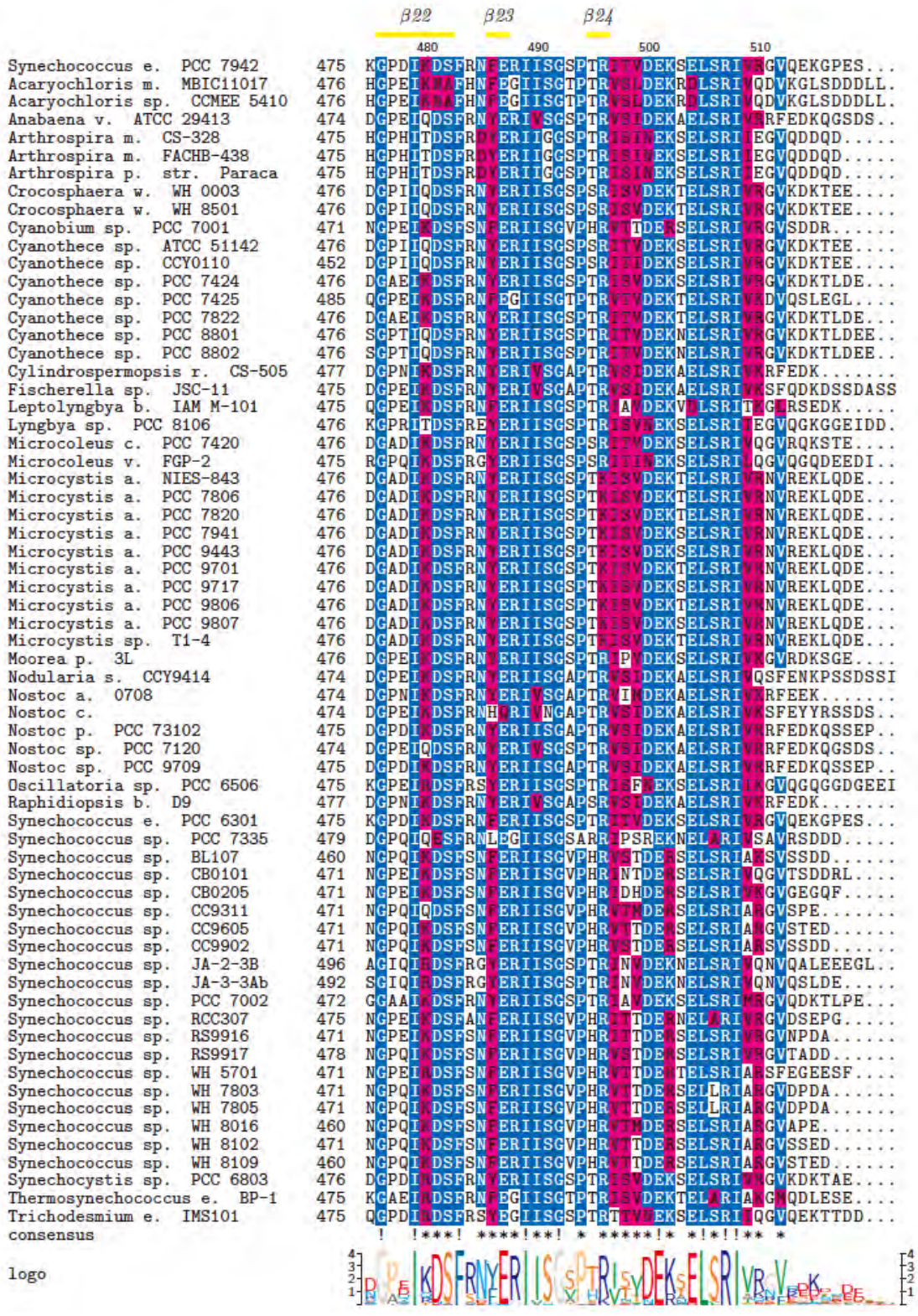
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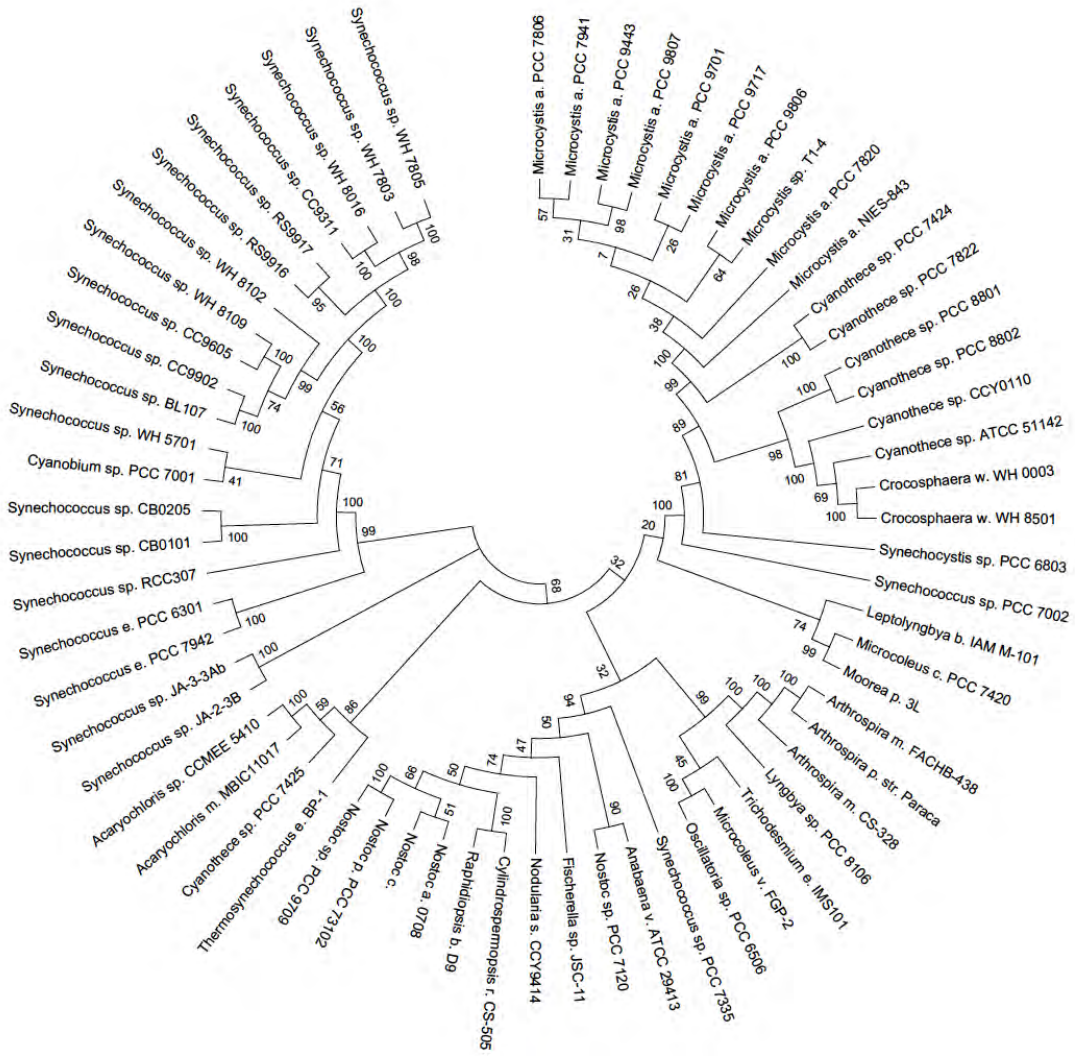
Thermosynechococcus e. BP-1 475 KGAEIRDSFRNFEGIISGTPTRISVDEKTELARIAMGMQDLESE....
Trichodesmium e. IMS101 475 QGPDIRDSFRSYEGIISGSPTRTIVDEKSELSRIIQGVQEKTTDD...
consensus ! !***! ****!**! * *****!* *!*!!** *
logo

(D)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Microcystis a. PCC 7941
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Microcystis a. PCC 9806
Microcystis sp. T1-4
Microcystis a. PCC 7820
Microcystis a. NIES-843
Cyanothece sp. PCC 7424
Cyanothece sp. PCC 7822
Cyanothece sp. PCC 8801
Cyanothece sp. PCC 8802
Cyanothece sp. CCY0110
Cyanothece sp. ATCC 51142
Crocosphaera w. WH 0003
Crocosphaera w. WH 8501
Synechocystis sp. PCC 6803
Synechococcus sp. PCC 7002
Leptolyngbya b. IAM M-101
Microcoleus c. PCC 7420
Moorea p. 3L
Arthrospira m. FACHB-438
Arthrospira p. str. Paraca
Arthrospira m. CS-328
Lyngbya sp. PCC 8106
Trichodesmium e. IMS101
Microcoleus v. FGP-2
Oscillatoria sp. PCC 6506
Synechococcus sp. PCC 7335
Anabaena v. ATCC 29413
Nostoc sp. PCC 7120
Fischerella sp. JSC-11
Nodularia s. CCY9414
Cylindrospermopsis r. CS-505
Raphidiopsis b. D9
Nostoc a. 0708
Nostoc c.
Nostoc p. PCC 73102
Thermosynechococcus e. BP-1
Cyanothece sp. PCC 7425
Acaryochloris m. MBIC11017
Acaryochloris sp. CCMEE 5410
Synechococcus sp. JA-2-3B
Synechococcus sp. JA-3-3Ab
Synechococcus e. PCC 7942
Synechococcus e. PCC 6301
Synechococcus sp. RCC307
Synechococcus sp. CB0101
Synechococcus sp. CB0205
Cyanobium sp. PCC 7001
Synechococcus sp. WH 5701
Synechococcus sp. BL107
Synechococcus sp. CC9902
Synechococcus sp. CC9605
Synechococcus sp. WH 8109
Synechococcus sp. WH 8102
Synechococcus sp. RS9916
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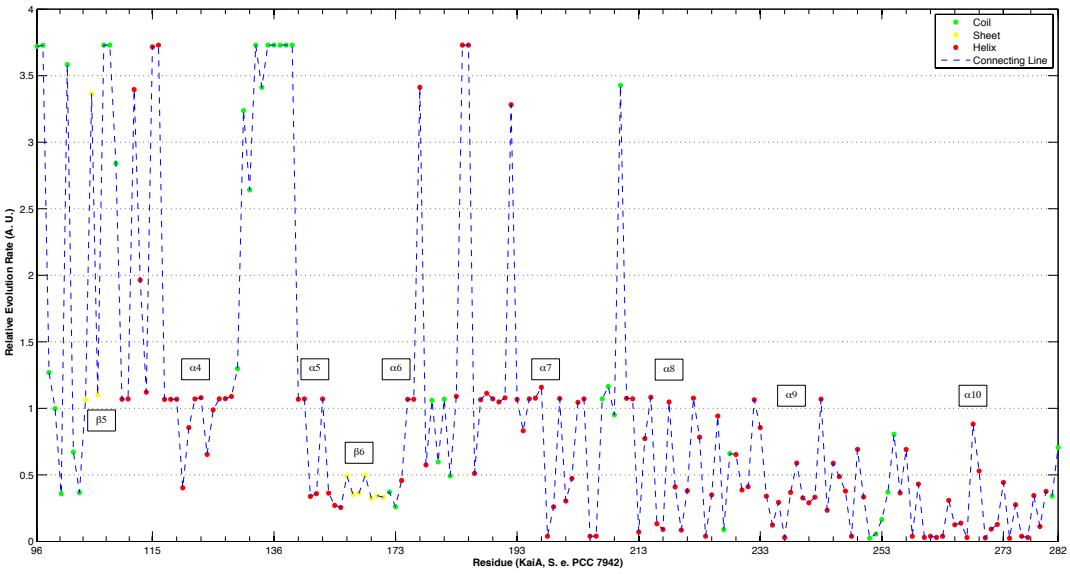
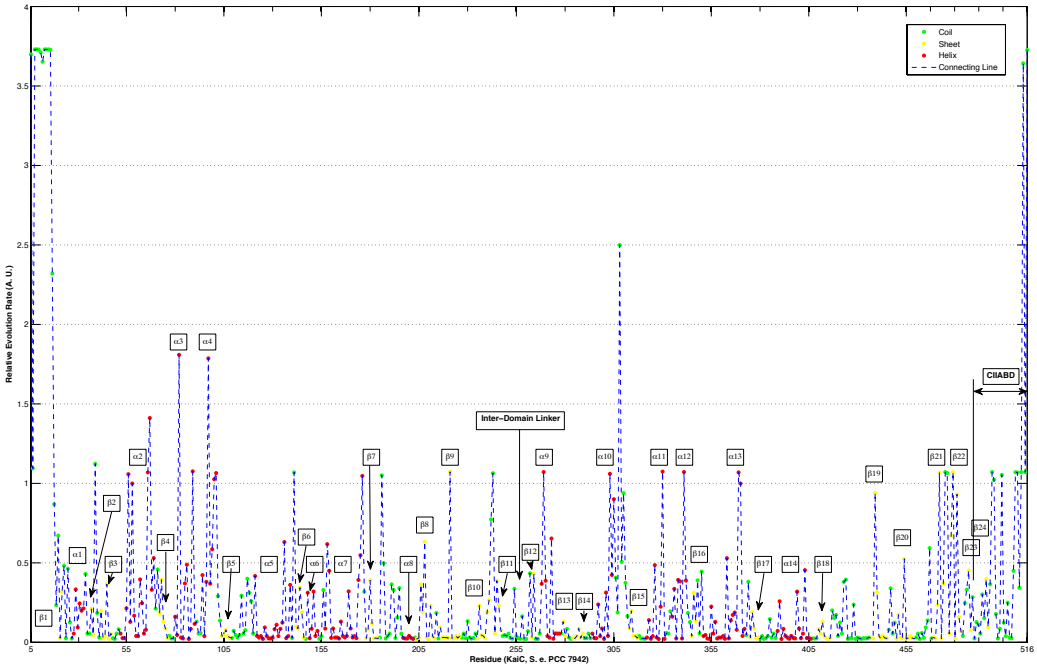
Synechococcus sp. WH 7805

(E)

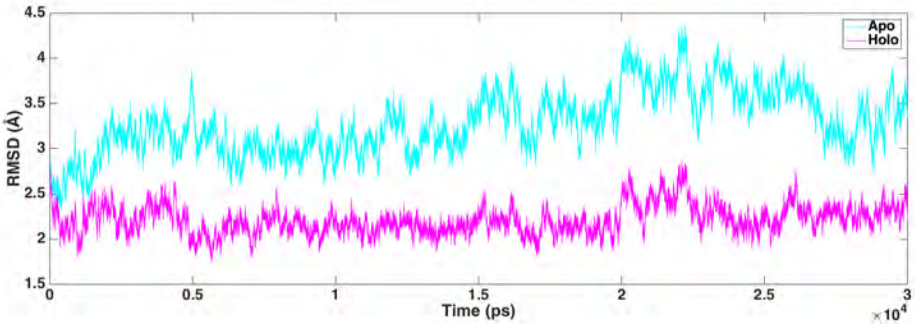

Coil
Sheet
Helix
Connecting Line
Relative Evolution Rate (A. U.)
Residue (KaiA, S. e. PCC 7942)
α4
α5
α6
α7
α8
α9
α10
β5
β6

(F)

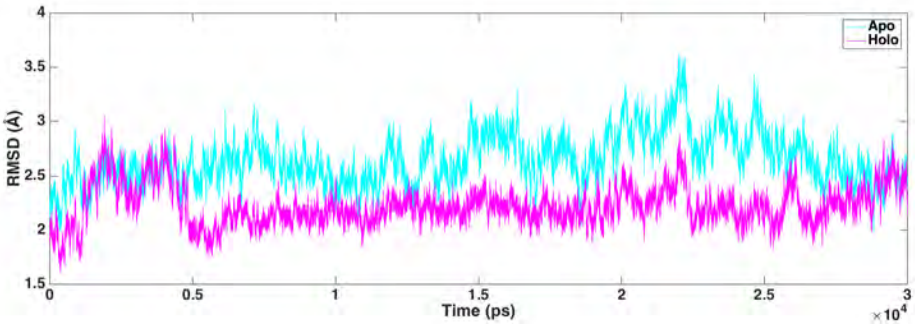

Coil
Sheet
Helix
Connecting Line
Relative Evolution Rate (A. U.)
Residue (KaiC, S. e. PCC 7942)
Inter−Domain Linker
CIIABD
α1
α2
α3
α4
α5
α6
α7
α8
α9
α10
α11
α12
α13
α14
β1
β2
β3
β4
β5
β6
β7
β8
β9
β10
β11
β12
β13
β14
β15
β16
β17
β18
β19
β20
β21
β22
β23
β24

Supplementary Figure S2. The molecular dynamics simulation of the apo structure of KaiA C-terminal domains (1Q6B). (A) The backbone RMSD variation of the whole C-terminal domains compared to the apo structure (1Q6B) and the holo structure (1SV1). (B) The backbone RMSD variation of the helices 9 and 10 compared to the apo structure (1Q6B) and the holo structure (1SV1) respectively. Compared to the simulation of the holo structure described in the main text, the conformational change of the apo structure had a lower oscillation frequency between these two conformations.

(A)



(B)



Supplementary Video S1. The snapshots of the molecular dynamics simulation of the apo structure of KaiA C-terminal domains. The apo structure (1R6B, in cyan) and the holo structure (1SV1, in magenta) are shown for comparison. Only 20 ns simulations were shown.

Supplementary Video S2. The snapshots of the molecular dynamics simulation of the holo structure of KaiA C-terminal domains. The apo structure (1R6B, in cyan) and the holo structure (1SV1, in magenta) are shown for comparison. Only 20 ns simulations were shown.