

## Supplementary Information

### **FttA is a CPSF73 homologue that terminates transcription in Archaea**

Travis J. Sanders,<sup>1</sup> Breanna R. Wenck,<sup>1</sup> Jocelyn N. Selan,<sup>1</sup> Mathew P. Barker,<sup>1</sup> Stavros A. Trimmer,<sup>1</sup> Julie E. Walker,<sup>1,2</sup> and Thomas J. Santangelo<sup>1\*</sup>

<sup>1</sup>Department of Biochemistry and Molecular Biology, Colorado State University, Fort Collins, Colorado 80523, USA

<sup>2</sup>Present address: Watchmaker Genomics, Boulder, Colorado 80303, USA

\*Correspondence to: [thomas.santangelo@colostate.edu](mailto:thomas.santangelo@colostate.edu).

**Supplementary Information Figure 1. Clustal-Omega alignment of diverse archaeal (coral), eukaryotic (green), and bacterial (blue) FttA-homologues.**

BLASTp searches of the *T. kodakarensis* FttA protein (WP\_011250379.1; TK1428) against all bacterial genomes revealed full-length homologues – containing both KH domains and the metallo-beta-lactamase (MBL) fold – in candidate species of *Rokubacterium*, *Wolfbacterium*, and *Staskawiczbacterium*, as well as *Tenericutes bacterium* and *Desulfuromonadales bacterium* C00003096. It should be noted that all Mollicutes (*e.g.* *Tenericutes* *sps.*), all Cyanobacteria, and some Firmicutes are devoid of obvious rho homologues<sup>12</sup>. Many eukaryotic CPSF73 proteins contain C-terminal extensions not found in archaeal or bacterial homologues; an exception is the YSH1 protein of *S. cerevisiae*. Conserved (.), well-conserved (:), and invariant (\*) residues are noted. An active center histidine (H255 in *T. kodakarensis*) is highlighted in red.

WP_011250379.1_Thermococcus_kodakarensis	----MIRRETFVDDILKEIREIIVQVMPREAGITDVEFEGPELVIVYVKNPEAMKDCGLI	56
WP_048048997.1_Methanosarcina_mazei	-----MPLEVDLDDLKHKEKNLPAQVITDVEFEGPQLVLYTEPRKFAADDGNI	51
WP_004044063.1_Haloferax_volcanii	-----MSSVQSLNLAIMEIIRNLTPEPTDIIISQIEYEGPEIAVYTKNPKLLEDNGLI	52
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	-----MVLMMNI I KEILSQLP-EEKISDACFEGANIVLYTKDKEFFLDNGLI	49
OLC36512.1_Thaumarchaeota_archaeon	MQRKTQQR---ELSPAPNIMGTILQSIPEKADVTKIDYEGPRIAITYTKNPRYLMHEHVI	57
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	-----MIFVSEDSLNLAIMEIIRNLTPEPTDIIISQIEYEGPEIAVYTKNPKLLEDNGLI	54
TALS1517.1_Nanoarchaeota_archaeon	-----MSKIKELKQIP-EDKISDAQFEGANIVLYTKDKEFFVNNGLI	44
WP_011007526.1_Pyrobaculum_aerophilum	-----MSFVE-IENKVKAILSGEIVKVNVEGPNLCIYVVRPTED---VIDMI	44
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	MPSRPLGGTQRPETIQSKIQVILQHVPKAEITRVEFEGPRLAIYTRKPEILLSSQSYIV	60
WP_014513953.1_Sulfolobus_islandicus	-----MNRLASLRNINTISLIYS-ELKDLGITRIEYEGPTIAVYVKKPTMVEKEVTI	52
WP_011277529.1_Sulfolobus_acidocaldarius	-----MSIRLNVNIAIYGMGPKKAGISKIDFEGPEIAVYVVRNPAVV---DGETV	46
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	-----MELEDVKSRLPKTAMITKTLFEGSDIVFYTKNKDFVNGSSDI	43
OLC64863.1_Candidatus_Rokubacteria_bacterium	-----MTIEDILNDARSVVKVFPDHVEITQVDFEGPTIVYTKNMEVFAESNDIV	51
OEU57241.1_Desulfuromonadales_bacterium_C00003096	-----MPAEATLLALKRRITELLPPDVSVTGVEFEGPELVLYTEDTQRFVDDGALV	51
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	-----MNCKLIETEILEKVRNALP-QEAI SRVELEGSELIVYTKDRDFVVKHEETV	50
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	-----MELLKN-ITDRL-KGKI TEASFEGANVLYTDAAEFPRRSGSKI	42
RKX64688.1_Tenericutes_bacterium	-----MGIEETLSELRQRIRKNLPGVGTISDVEFEGPELVLYTKPRKRLADNGEIV	51
NP_057291.1_Homo_sapiens	-----	0
NP_650738.1_Drosophila_melanogaster	-----	0
NP_502553.2_Caenorhabditis_elegans	-----	0
NP_013379.1_Saccharomyces_cerevisiae	-----	0

WP_011250379.1_Thermococcus_kodakarensis	KNLAKVLKRRISVRPDDPILLPPEKAEELIKQLVPEAEITNISDFPSVGEVLEIARKPG	116
WP_048048997.1_Methanosarcina_mazei	RNLAKELRTRIAMRPPVRLATPEDSISIIEEVVPEKESISSYDFDPSGEVIEAEKPG	111
WP_004044063.1_Haloferax_volcanii	RKLAKLKRRIIVRPDDPDLSDPRAEAPKILSVIPEAGVTDLDPHIDTGEVVEAEKPG	112
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	RKIVNDIKRVELRPPDAITLIEDAEALKISVPIPEAGVDKIIDFPQSRVIEAEKPG	109
OLC36512.1_Thaumarchaeota_archaeon	SNMNVNKKRIIVRSDPEIRMKPEAEERFIRSIIVPEAEITNITFDENIGEVVEAEKPG	117
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	KNLAKLKRRIIVRSDPVRDRKEETANYIRTLVTDSEITKVTFDENMGEVTEAEKPG	114
TALS1517.1_Nanoarchaeota_archaeon	RKIVDDIKRVELRPPDKITSDPVKAEERKIMVPEAGVSNVDFPARSQVIEAEKPG	104
WP_011007526.1_Pyrobaculum_aerophilum	GEVAKTLKRRVILRVPNSRASEKTAASKVIREVLSDD---VEDVVFENN-GDVIYLAAPL	100
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	SDIVSLIRKRIIVRSDPEIRMKPEAEERFIRSIIVPEAEITNITFDENIGEVVEAEKPG	120
WP_014513953.1_Sulfolobus_islandicus	KKIAKDKKRII KADPSVRDKKEAVEIKKIIVTPEAVIDIKFDDDLGEVLIKAKKPG	112
WP_011277529.1_Sulfolobus_acidocaldarius	KKIAKEIKRVRVADPKSRDKKEETKEIKNIIVPQEAQIIDIKFDDDLGEVLIKAKKPG	106
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	KALVSEIRKRIINLRPDQSIITLAEADKAREKIRTVIPKAEIQDILFEPFEGKVIILAQKPG	103
OLC64863.1_Candidatus_Rokubacteria_bacterium	RQIAQQLRRRIIVRSDPILLSAQEDAERKIREVPEAGITGVYFETETGEVTEALAPG	111
OEU57241.1_Desulfuromonadales_bacterium_C00003096	RTLAKELKRRISVRPSSDILMDPEKASKAHEIIPPEGGIKDIYFDMDKAEVIEAEKPG	111
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	RQVVDLKKRIIVRSDPEIRMKPEAEERFIRSIIVPEAEITNITFDENIGEVVEAEKPG	110
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	KEIVNEIKKRIELRADKILKDAEETEKEIRKSIPEAEITNITFDENIGEVVEAEKPG	102
RKX64688.1_Tenericutes_bacterium	RSTIAQVRRKRIIVRSDPVLSDPADATAAEIKIAPSDAGITDYCFDSDTGEVVEAEKPG	111
NP_057291.1_Homo_sapiens	-----	0
NP_650738.1_Drosophila_melanogaster	-----	0
NP_502553.2_Caenorhabditis_elegans	-----	0
NP_013379.1_Saccharomyces_cerevisiae	-----	0

WP_011250379.1_Thermococcus_kodakarensis	LVIGKNGETLRLITQKVHWPVRVTRTP-----IQSQTIIYSIRSIQTESKDRRKLFRQV	171
WP_048048997.1_Methanosarcina_mazei	LVIGKHGATREITKQIGWIPKVVTRTP-----IKSRTVKNIREFMRNKLKERKELIKTV	166
WP_004044063.1_Haloferax_volcanii	MVIGRHGSTRLEITQKVGWTEVVRTRTP-----IESSTVSNRNLKQERDRRRLIERT	167
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	LAIGKQGDILREIRKTLWVPLIRKKA-----IRSQLIENIRAVLYQNSDYRRKFLDKI	164
OLC36512.1_Thaumarchaeota_archaeon	LLNNAEVENMVDLVSITGWVRRIRKATT-----AQSQTIQIINYNLKIISSTERSKHLRQI	172
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	LVIGKLGANRISIRMETLWRPIVVRTRTP-----IDSKTVKIVRHLKTERGVKELLIRI	169
TALS1517.1_Nanoarchaeota_archaeon	LAIGKQGSILREIREKTFWVFFIRTRTPA-----IRSVLIENIRAVLYQNSDYRRKFLHVK	159
WP_011007526.1_Pyrobaculum_aerophilum	R-EKEIKSATREIPVKTGWRAVIESGVKDRVLPKTHEIVGRVIRFHSAVAQRMELMESL	159
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	LVISKNGATLQEIIVKTVKWRPILRTRTP-----IPSKI IAHIRHLYQVQEKORILRSV	175
WP_014513953.1_Sulfolobus_islandicus	LVIGKGGSLQRIIPAEITFWKAEIVREPP-----IRSRTYDSILEHLYNETEYRAKILKVF	167
WP_011277529.1_Sulfolobus_acidocaldarius	LVIGKGGSIQKIIIPAEITFWVWRPIVREPP-----LKSRTYDGLVTHIYNETEYRAKALRFI	161
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	IVIGKGTREIREIKTFWVFNPIQRMPG-----FRSKIVNKAREIVHEEAKYRQOFLNKI	158
OLC64863.1_Candidatus_Rokubacteria_bacterium	MVIGRHGGSVLEIKKRIWAPKVVTRTP-----IPSKTVEEIRQYLRITINDERQVFLKQV	166
OEU57241.1_Desulfuromonadales_bacterium_C00003096	LVIGTHGATREITKQIGWIPKVVTRTP-----IQSPTIKSIRRYLREESDFRKSFLKQV	166
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	LVIGRGGTFRQIRAEITFWVPRIRVTRTP-----IKSDVIDGIRKVLHQVFKRKEFLNKI	165
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	MVIGKRGILDELKHTFWSQVQRSPA-----IKSKIVENIREVLYANNYRRRFLNSV	157
RKX64688.1_Tenericutes_bacterium	LVIGQHGSMLEIRITRYIGWTPKVVTRTP-----IESSTKNVRHVLRESLDERKQILREL	166
NP_057291.1_Homo_sapiens	-----	0
NP_650738.1_Drosophila_melanogaster	-----	5
NP_502553.2_Caenorhabditis_elegans	-----MTQAT	0
NP_013379.1_Saccharomyces_cerevisiae	-----	0

WP_011250379.1_Thermococcus_kodakarensis	GRNIYR---KSEYKSRWIRITGLGGFREVGRSALLVQTDSESVLVDFGVNIAALKDPTKAY	229
WP_048048997.1_Methanosarcina_mazei	GRKIHR---ECTSKDQWVVRTALGGCKEVGRSFLLS*PESRILIDCGVNGVSGDE---NMT	221
WP_004044063.1_Haloferax_volcanii	GROIHR---EQLSDEEWRITLGLCCREVGRASFIVS*PETRILVDCGDKPGSD---DV	220
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	GHRIDYDQWIREKKNWIRVSVLGGARQVGRSCLFLQ*PESRILIDCGVNIAS-D-KDAY	221
OLC36512.1_Thaumarchaeota_archaeon	GEQIFR---PKLSEDAEVSILITLGGFQVGRSCLL*THESKILVDCGVPNGA-RSPMEAF	229
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	GKRIHR---PVIKPDATIKLTALGAPREVGRSCLLQVNSQES*TVLVDGCLNNGS---PTEPF	224
TALS1517.1_Nanoarchaeota_archaeon	GRIYDSVWREKREGWIRVSVLGSAREVGRSCLLQ*NESRVLLDCGINIAA-NSPDLAY	218
WP_011007526.1_Pyrobaculum_aerophilum	ARYIHQ---EPVVKGEPTITVPLGAAMEVGRSALLV*STNESVLLDCGLKPAQN---DEEF	214
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	GRIIFR---APIYKQSVLITPLGGFQVGRSALLV*STNESVLLDCGINPCT-ANPESDF	232
WP_014513953.1_Sulfolobus_islandicus	GRIIFR---EIVQKDFVIRITLALGPLEVGRSALLV*STNESVLLDCGINPCT-ANPESDF	225
WP_011277529.1_Sulfolobus_acidocaldarius	GRIIFR---DILFKDFVIRITLALGPLEVGRSALLV*STNESVLLDCGINPCT-ANPESDF	218
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	GQKIQI---KKGSGEGRVRSALGSGFVGRSCLLQ*TESKVLVLLDCGINVNGS-N---EMN	212
OLC64863.1_Candidatus_Rokubacteria_bacterium	GRRLAR---EVPNGEIVRITLALGGFQVGRSALLS*TRLSKVLIDCGVLSIED---NGS	220
OEU57241.1_Desulfuromonadales_bacterium_C00003096	GRIIFR---DKSKEDEWIRITLALGGFQVGRSALLS*TRLSKVLIDCGVLSIED---NGS	219
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	GKIFPS---ERKNTDWRITLIPLGGFQVGRSCLL*ETPKSKVLIDCGIAPGC-QG-ADAF	221
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	GKIIYEDWDPKRTDEWIRITLPLGARQVGRSCLLQ*TPNSKVLVLLDCGINVSS-QG-EDFK	215
RKX64688.1_Tenericutes_bacterium	GKIIHR---SITSPDNIRITLALGGFQVGRSCLL*TPTRVLLDCGINVADDDH---GTT	222
NP_057291.1_Homo_sapiens	---MSA---IPAESDQLLRPLRPLGAGQEVGRSCLILEFGRKIMLDCGHPGLE---GMDAL	53
NP_650738.1_Drosophila_melanogaster	---GDAR---MPDEESDLQIKPLGAGQEVGRSCLIMLEFGRKIMLDCGHPGLE---GMDAL	52
NP_502553.2_Caenorhabditis_elegans	---ME---EGDSDSLCFTPLGSGEVGRSCLILEYKGRVMLDCGHPGLH---GVDAL	59
NP_013379.1_Saccharomyces_cerevisiae	---MERTNTTTFKFFLGGSGEVGRSCLILQYKGTVMLDAGIHPAYQ---GLASL	50

WP_011250379.1_Thermococcus_kodakarensis	PHFDAPEFRYVLDGLLDAIITHA	LDHSGMLPYLFRYKLDGPIYITPPTRDLMTLLQ	289
WP_048048997.1_Methanosarcina_mazei	PYLYVPEVF---PLNQIDAVIVTHA	LDHQGLVPLLFKYG-YEGPVYCTPPTRDLMLVLLQ	277
WP_004044063.1_Haloferax_volcanii	PYLQVPEAL-GSGANLDAVLTSHA	LDHSALIPLLFKYG-YDGPYITTEPRDLMLGQT	278
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	PYLEAPEFN----INLDAVLTSHA	LDHCGFIPYLYKYG-YRGPVYCTAPTRDVSALL	276
OLC36512.1_Thaumarchaeota_archaeon	PRLDWPNIT---LDELDAVISHA	LDHTGFLPVLKYG-YRGPVYCTEPLPMNLLQ	284
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	PLFDLPVFD---IDSLDAVITSHA	LDHSGMIPYLYKYG-YDGPYISTPLRHLSTMLQ	279
TAL51517.1_Nanoarchaeota_archaeon	MLEAPEFED---LQKLDAILSHA	LDHCGFIPYLYKYG-FRGPVYCTPPTRDISALM	273
WP_011007526.1_Pyrobaculum_aerophilum	PLLDLID----IDRLDAVLTSHA	MDHVGLCPFLFKYG-YRGPVYCTDTPKYQAFILL	267
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	PRLDNEFD---LSDDAVISHA	LDHCGLLPPLYKYG-YDGPVYCTEPLSLMALLQ	287
WP_014513953.1_Sulfolobus_islandicus	PRLDIDQLK---IEELDAVITSHA	LDHCGMVPFLFKYG-YEGPVYTPVTRDIMALMQ	280
WP_01127529.1_Sulfolobus_acidocaldarius	PRLDIDQVK---LEDDAVITSHA	LDHCGMVPFLFKYG-YEGPVYTPVTRDIMALAQ	273
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	PYIDAPEFD---LESDDAVISHA	LDHSGFAPLYEYG-YKGPLYITPLTRDVMTLLQ	267
OLC64863.1_Candidatus_Rokubacteria_bacterium	PYLNAPVEM---PLGSDAVITSHA	LDHSGLVLPALYKYG-YDGPYITPPTRDLMSLLQ	276
OEU57241.1_Desulfuromonadales_bacterium_C00003096	PYLYVPEVT---PLSDIDAVITSHA	LDHTGLVPLLFQYA-YDGPYIMTQPTDLMLVLL	275
OGM94118.1_Candidatus_Wolfbacteria_bacterium	PLLTTKFED---PAELDAVISHA	MDHVGFVPLFEYG-YEGPLYCTPTDLDFALLD	276
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	PIFNIPEDF---INQLDAVISHA	IDHVGMPVFLKYM-YRGPVYMLPTDRDISLLA	270
RKX64688.1_Tenericutes_bacterium	PYLYPEVVS---PITHLDGVVTHA	LDHCGLVPLLFKYG-YRGPVYATPPSRDLMALQ	278
NP_057291.1_Homo_sapiens	PYIDLID----PAEIDLILLSHF	LDHCGALPWLQKTSFKGRFMTHATKAIYRWLL	107
NP_650738.1_Drosophila_melanogaster	PYVDLIE----ADEIDLLFISHF	LDHCGALPWLKMTSFKGRCFMTHATKAIYRWLL	113
NP_502553.2_Caenorhabditis_elegans	PFVDVFE----IENIDLLITHF	LDHCGALPWLQKTAFOGKCFMTHATKAIYRWLL	106
NP_013379.1_Saccharomyces_cerevisiae	PYDFEFD----LSKVDLILLSHF	LDHAASLPYVMQRTNFQGRVFMTHATKAIYRWLL	104

WP_011250379.1_Thermococcus_kodakarensis	QDFIEIQHMNG-----VEPLYRPKDIKEVIKHTITLDYGEVRDIAPDIRLTLHNAGH	341
WP_048048997.1_Methanosarcina_mazei	LDYIDVAKEG-----KKIPYESGMVAKTLKHTIPLDYEEVTDIAPDIKLTFNHAG	329
WP_004044063.1_Haloferax_volcanii	LDYLDVASKEG-----RTPPYESEMVREAIKHTIPLDYEGDVTDIAPDVKLTFNHAG	330
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	LDYIKIMRNSG-----KEPFTIDDIKEMVKHTICLDYNEVSDITPPVRIITYNAGH	328
OLC36512.1_Thaumarchaeota_archaeon	LDIAKVAQAQ-----KVPLYSERDVQVMKQITPLSYGVVTDISPDIKLVFSNAGH	336
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	LDYIQITEKG-----KICPYKKGVDKDAVLTIPLQYGEVTDIAPDIKLTNHSNGH	331
TAL51517.1_Nanoarchaeota_archaeon	IDAVIKIQRSEN-----KEPLYTTEVKEVFKHTITLDYGEVTDITPDIRITFNHAG	325
WP_011007526.1_Pyrobaculum_aerophilum	SDVVELKEREK-----LQPSYSKADITVIYHTITLDYEEVTDIAPDIKLTFFDAGH	319
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	LDYLDVLSREG-----IQPPYDQKDVREMLHTIPLRQYGVVTDIAPDIKLTNHSNGH	339
WP_014513953.1_Sulfolobus_islandicus	LDLSDVVEKEG-----KPLPYSAAKEVRKELLHTITLDYGEVTDIAPDIRLTFYNAGH	332
WP_01127529.1_Sulfolobus_acidocaldarius	LDALDVVAKEG-----RPYPYTAKEVRRELLHTITLDYGEVTDIAPDVKLTFNHAG	325
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	LDIDVQLRET-----GKAPYTSMGIKNAIKHSITLDYNEVCDITPDMRLTFQNGH	319
OLC64863.1_Candidatus_Rokubacteria_bacterium	IDIKVAMGEA-----RKSPYDSSNIRKAVANTIPLKYGETTDIAPDVRLTFQNGH	328
OEU57241.1_Desulfuromonadales_bacterium_C00003096	LDYLEVAAREG-----NKIPYKSSRIDAIRHTIPLKYGDVTDISPDIKLTNHSNGH	327
OGM94118.1_Candidatus_Wolfbacteria_bacterium	LDYIDVAQNG-----VNPAYTVKGVKAVRHSISLEYGEVSDVAPDVRLTFQNGH	328
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	LDIFGVAYKQA-----EKPLYSSTDIKEMVKHSICLDYNEVSDITPDIRITFNHAGH	322
RKX64688.1_Tenericutes_bacterium	IDYIDVAMKEG-----RRIYPSSEMVREALKHTITLDYGSVTDIAPDMKLTNHSNGH	330
NP_057291.1_Homo_sapiens	SDYVKSMSISA-----DMLYTTELDSESMKDIETINFEHVKEVA-GIKFVCYHAGH	158
NP_650738.1_Drosophila_melanogaster	SDYIKISNITP-----EQMLYTEADLEASMEKIETINFEHRDVM-GVRFCAIYAGH	164
NP_502553.2_Caenorhabditis_elegans	GDVVRISYKGGP-----DRNQLYTEDELKSMAKIETIDFRQKEVN-GIRFPYVAGH	159
NP_013379.1_Saccharomyces_cerevisiae	RDFVRRVTSIGSSSSMGTKEGLFSDDELVDVDFDKIETVDYHSTVDVM-GIKFTAFHAGH	163

WP_011250379.1_Thermococcus_kodakarensis	ILGSSIVHLHIGNGLHNIAITGDFKFIPTRLPEFAPSRFRLETLVMESTYGGSDNYQMP	401
WP_048048997.1_Methanosarcina_mazei	ILGSAISHFHI GDLGNVVTGDKYKERTLFDPAVNFPRVETVISEATYGNANAFQPA	389
WP_004044063.1_Haloferax_volcanii	ILGSAVSHFHI GDLGNVAVSGDIHYEDTRLPNGAVNDFPRVETLVLESTYGGSDNYQMP	390
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	ILGSSMVMHVMGGLNHI VYTGDMKFGKTRLLDIAVTKFPRVETLMIESTYGGSDNYQMP	388
OLC36512.1_Thaumarchaeota_archaeon	ILGSAVSHFHI GNGNHNFYSGDLKYGKSMLEPESAVNFWPRIETLLIESTYGAKEDIQAT	396
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	ILGAALVHLHIGEGAAHNLVVTGDFKFKQKTRLESATVNFPRLETLVTEATYGGKDEIPT	391
TAL51517.1_Nanoarchaeota_archaeon	ILGSAMTHLHI GNLGNLNLVYSDSKYAKTSLLDPAVTFDPRLESMLIESTYGGSDNYQMP	385
WP_011007526.1_Pyrobaculum_aerophilum	EIGSAMAHLHI GNGRYNLYTGDFKFKQKTRLLNRAANKFKRVEMLIMESTYGGSDNYQMP	379
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	ILGSAIHLHI GEGLNHIVYTGDFKFKAKTMLLESASVAPRLETLMIEATYGSSEVDMVP	399
WP_014513953.1_Sulfolobus_islandicus	ILGSAMAHLHI GDEGKHIVYTGDFKFKAKTMLLDKANTEFPRVDTLMIMETTYGAQD--QPN	390
WP_01127529.1_Sulfolobus_acidocaldarius	ILGSAMAHLHI GEGLNHIVYTGDFKFKAKTMLLDKANTEFIRVDTLMIMETTYGAHD--QPN	383
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	ILGSALTHIHI GEGLNHLLYADLKGKPTKLEPAYMGFSRIESMLIESTYGAKPDIIPS	379
OLC64863.1_Candidatus_Rokubacteria_bacterium	ILGSAVSHFHI GDLGNVAVSGDIKFKETWLPNPAVNFPRLETLVLESTYGGYHDIQPS	388
OEU57241.1_Desulfuromonadales_bacterium_C00003096	ILGSSVYVPHVGNGLNHI AFSGDIKYERTLFDPAFNGFPRLETLIMESTYGGANDMQP	387
OGM94118.1_Candidatus_Wolfbacteria_bacterium	ILGSAVHLHI GEGMHNIVYGLDQKPARTNLLEPAFTDFQRCETLLIESTYGGVADIQPP	388
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	VLGSAMVHI NI GNGSNLTYTGDFKFKMTRLEPATIYFPRLESVITESTYGAKEVDFQP	382
RKX64688.1_Tenericutes_bacterium	ILGSAVSHFHVGDGLNHLVVTGDFKFKYKTRLFDSAINNPRAEVIMIEATYGGPNDPQP	390
NP_057291.1_Homo_sapiens	VLGAAMFMEIA--GVKLLYTGDFSRQEDRHLMAAEIPNKPDIILIESTYGTHI--HEK	214
NP_650738.1_Drosophila_melanogaster	VLGAAMFMEIA--GKILYTGDFSRQEDRHLMAAEVPMKPDVILIESTYGTHI--HEK	220
NP_502553.2_Caenorhabditis_elegans	VLGACQFMEIA--GVRVLYTGDFSCLEDRHLCAAEIPPTQVILIESTYGTQ--HEK	215
NP_013379.1_Saccharomyces_cerevisiae	VLGAAMFQIEIA--GLRVLTGDFYSREVDRLHNSAEVPLSSNVLIEVSTFGTAT--HEP	219

WP_011250379.1_Thermococcus_kodakarensis	REEAEKRLIEVHITLKRGGKVLIPAMAVGRAQEIIMVLEEYARVGGI----EVPYIYLD	456
WP_048048997.1_Methanosarcina_mazei	LKDAEKHLQMVVKNTERGGIIVIPAFVAVGRSQEVMIVLEESIRKGLI----PEVPVYLD	445
WP_004044063.1_Haloferax_volcanii	QQDSEERLIEVINETYDRGGKVIIPAFVAVGRSQEIMLVLEAMRSGKI----PEMPVHLD	446
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	RKCEENEFADIKRTIDRKGILVPLVLSGGRSQEVLINVENIRNGKI----EKVPVFD	444
OLC36512.1_Thaumarchaeota_archaeon	REVEVEGAFVKSNETLRNGGKVLIPAVGRAQELMMVINQYMLGQL----MEAPVTE	452
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	RHESQELVNLINTLMRGGKMLIPVAVGRAQEIILIEEMIAKAKRI----EAVPVYVD	447
TAL51517.1_Nanoarchaeota_archaeon	KESEDEYLAHVKNITLARGGKILIPVAVGRAQEIIMVIVNLRAGSI----DAVPIYLD	441
WP_011007526.1_Pyrobaculum_aerophilum	RVEAENALAKHVSDAVTRGGKVLIPAFVAVGRSQEILVILNKMMEGGLI----PRVPVYVD	435
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	RPEVEARFVSIIVNTRNGGKVLIPVAVGRAQEIIMLVLDQHIRNGSL----PEVPIYLD	455
WP_014513953.1_Sulfolobus_islandicus	RESESELEIEINKTLNRGGKVLIPVAVGRSQEIMLINDFMKKKLI----PEVPIYLD	446
WP_01127529.1_Sulfolobus_acidocaldarius	RESEALKIDIINKTISGGKVLIPVAVGRSQEIMLVINDAMKMKI----PEVPIYIT	439
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	KREADMNLMEVIKRTINRGGKVIIPAFVAVGRAQEVVVLDAEYSRGL----EVPVYLD	434
OLC64863.1_Candidatus_Rokubacteria_bacterium	RHEAQQKKEVIRRVLRGGKVLIPVAVGRSQEVMVLEEDAMNRQI----PEVPIYLD	444
OEU57241.1_Desulfuromonadales_bacterium_C00003096	RREAEKRLDAVTKTERGGKVIIPAFVAVGRSQEVMIALEG----MD----LEVPIYLD	438
OGM94118.1_Candidatus_Wolfbacteria_bacterium	RQETERMFLDAVNKTEAGAGVLPFAVAVRAQEMMTILATN----N----FQYVYLD	439
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	RREAEKFDLNTMTIERGGKVLIPVAVGRAQETMLIETADIAKGRM----KKIPVYLD	438
RKX64688.1_Tenericutes_bacterium	RNVAEKNISEIVKRTIERGGKVIIPAFVAVGRSQDVMVLEAMRKKRI----EQVPIYLD	446
NP_057291.1_Homo_sapiens	REEREARCNTVHDIIVNRGGKVLIPVAVGRAQELLLILDEYQNHPEL----HDPIIYA	271
NP_650738.1_Drosophila_melanogaster	REDRENRFSLVQVQGGKVLIPVAVGRAQELLLILDEYQNHPEL----HDPIIYA	277
NP_502553.2_Caenorhabditis_elegans	RAVREKRTQMVHIVTRGGKVIIPAFVAVGRAQELMLILDEYQNHPEL----HDPIIYA	272
NP_013379.1_Saccharomyces_cerevisiae	RLNREKRLTQLIHSTVMRGGKVLIPVAVGRAQEIIMLVLEAMRKKRI----HDPIIYA	279



WP_011250379.1_Thermococcus_kodakarensis	-----	648
WP_048048997.1_Methanosarcina_mazei	-----	637
WP_004044063.1_Haloferax_volcanii	-----	640
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	-----	633
OLC36512.1_Thaumarchaeota_archaeon	-----	643
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	-----	638
TAL51517.1_Nanoarchaeota_archaeon	-----	633
WP_011007526.1_Pyrobaculum_aerophilum	-----	634
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	-----	646
WP_014513953.1_Sulfolobus_islandicus	-----	638
WP_011277529.1_Sulfolobus_acidocaldarius	-----	631
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	-----	626
OLC64863.1_Candidatus_Rokubacteria_bacterium	-----	635
OEU57241.1_Desulfuromonadales_bacterium_C00003096	-----	628
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	-----	630
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	-----	627
RKX64688.1_Tenericutes_bacterium	-----	541
NP_057291.1_Homo_sapiens	VKRNFNHYHLSPCDLSNYTDLAMSTVKQTQAIPTGPFNLLCYQLKLTGDVEELEIQE-	544
NP_650738.1_Drosophila_melanogaster	VKRDFFKHYLLAPSDLGKYTDMMSVVTQRQSIPWGSLSLTLLELLDRIGAGCQVEV-LEA-	549
NP_502553.2_Caenorhabditis_elegans	VKNPFSYIMVPEELGSYTSLSRISLEQRMSVHYSGLKLLIFNLQLNDACLINIKL	545
NP_013379.1_Saccharomyces_cerevisiae	-----	474

WP_011250379.1_Thermococcus_kodakarensis	-----	648
WP_048048997.1_Methanosarcina_mazei	-----	637
WP_004044063.1_Haloferax_volcanii	-----	640
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	-----	633
OLC36512.1_Thaumarchaeota_archaeon	-----	643
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	-----	638
TAL51517.1_Nanoarchaeota_archaeon	-----	633
WP_011007526.1_Pyrobaculum_aerophilum	-----	634
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	-----	646
WP_014513953.1_Sulfolobus_islandicus	-----	638
WP_011277529.1_Sulfolobus_acidocaldarius	-----	631
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	-----	626
OLC64863.1_Candidatus_Rokubacteria_bacterium	-----	635
OEU57241.1_Desulfuromonadales_bacterium_C00003096	-----	628
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	-----	630
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	-----	627
RKX64688.1_Tenericutes_bacterium	-----	541
NP_057291.1_Homo_sapiens	-----KPALKVF---KNIITVIQEPGMVLEWLANPNSNDMYADTVTIVILEVQSNPK	592
NP_650738.1_Drosophila_melanogaster	-----ERKLRVF---GCIELTVEQKLIIVMEWQATHVNDVYADAVLACIMQSELGCT	597
NP_502553.2_Caenorhabditis_elegans	KEISKKGVSVTQAITVFGQKVVVTVYGNHVVVVRWDSNPFVYDYMADSVVAAILHAQANFV	605
NP_013379.1_Saccharomyces_cerevisiae	-----	474

WP_011250379.1_Thermococcus_kodakarensis	-----	648
WP_048048997.1_Methanosarcina_mazei	-----	637
WP_004044063.1_Haloferax_volcanii	-----	640
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	-----	633
OLC36512.1_Thaumarchaeota_archaeon	-----	643
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	-----	638
TAL51517.1_Nanoarchaeota_archaeon	-----	633
WP_011007526.1_Pyrobaculum_aerophilum	-----	634
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	-----	646
WP_014513953.1_Sulfolobus_islandicus	-----	638
WP_011277529.1_Sulfolobus_acidocaldarius	-----	631
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	-----	626
OLC64863.1_Candidatus_Rokubacteria_bacterium	-----	635
OEU57241.1_Desulfuromonadales_bacterium_C00003096	-----	628
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	-----	630
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	-----	627
RKX64688.1_Tenericutes_bacterium	-----	541
NP_057291.1_Homo_sapiens	IRKGAQVQVSKKLEMHVYSKRLEIMLQDIFGEDCVSV-KDDSIILSVTV-DGKTANLNLET	650
NP_650738.1_Drosophila_melanogaster	NLRGATKQT--KSEDSRFRECLIEITLQDTPFGDNCVPMFEGDLLPVTV-SGKRAEINLET	654
NP_502553.2_Caenorhabditis_elegans	PDKYLP----SNSSFPPQNTAIEGMVKHICGDDVSIVMSEGLLAQFEEDGRRLLVEGSS	661
NP_013379.1_Saccharomyces_cerevisiae	-----	474

WP_011250379.1_Thermococcus_kodakarensis	-----	648
WP_048048997.1_Methanosarcina_mazei	-----	637
WP_004044063.1_Haloferax_volcanii	-----	640
OIO62505.1_Candidatus_Woeseearchaeota_archaeon	-----	633
OLC36512.1_Thaumarchaeota_archaeon	-----	643
OLS12352.1_Candidatus_Lokiarchaeota_archaeon_CR_4	-----	638
TAL51517.1_Nanoarchaeota_archaeon	-----	633
WP_011007526.1_Pyrobaculum_aerophilum	-----	634
RLI34429.1_Candidatus_Bathyarchaeota_archaeon	-----	646
WP_014513953.1_Sulfolobus_islandicus	-----	638
WP_011277529.1_Sulfolobus_acidocaldarius	-----	631
RLG13324.1_Candidatus_Nanohaloarchaeota_archaeon	-----	626
OLC64863.1_Candidatus_Rokubacteria_bacterium	-----	635
OEU57241.1_Desulfuromonadales_bacterium_C00003096	-----	628
OGM94118.1_Candidatus_Wolfecubacteria_bacterium	-----	630
OGZ62538.1_Candidatus_Staskawiczbacteria_bacterium	-----	627
RKX64688.1_Tenericutes_bacterium	-----	541
NP_057291.1_Homo_sapiens	--RTVECEEGSEDDSLREMVLEAAQRLYEALTPVH-----	684
NP_650738.1_Drosophila_melanogaster	--LAISCAEDDV---LRQLMNTTVQKLHQLTVSAL-----	684
NP_502553.2_Caenorhabditis_elegans	DGPVMMGGDDPMDPTTSHLLQNLTEKMRQIVTNTNEVNEIDDMEC	707

**Supplementary Information Figure 2. SDS-PAGE of total cell lysates derived from *T. kodakarensis* strains IR5 and TS559 grown in the absence and presence of NaF.** 10 µg of total protein from each strain grown in the absence or presence of 4 mM NaF was resolved via SDS-PAGE prior to transfer and quantification of FttA-levels via Western blots as shown in Figure 4, panel h (n = 3). Lane M contains Magic Mark protein ladders identified by molecular weight in KDa.

