

University of Groningen

A novel relaxase homologue is involved in chromosomal DNA processing for type IV secretion in *Neisseria gonorrhoeae*

Salgado-Pabon, Wilmara; Jain, Samta; Turner, Nicholas; van der Does, Chris; Dillard, Joseph P.

Published in:
Molecular Microbiology

DOI:
[10.1111/j.1365-2958.2007.05966.x](https://doi.org/10.1111/j.1365-2958.2007.05966.x)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2007

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Salgado-Pabon, W., Jain, S., Turner, N., van der Does, C., & Dillard, J. P. (2007). A novel relaxase homologue is involved in chromosomal DNA processing for type IV secretion in *Neisseria gonorrhoeae*. *Molecular Microbiology*, 66(4), 930-947. DOI: 10.1111/j.1365-2958.2007.05966.x

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

P.rettgeri |AAM08003.1| -----
V.cholerae MO10 |EAZ47260.1| -----
V.cholerae |ABA87024.1| -----
Shewanella W3-18-1 |YP_962502.1| -----
Y.p.orientalis IP275 |ZP_01175343.1| -----
X.c.vesicatoria 85-10 |YP_364087.1| -----
Acidovorax JS42 |ZP_01384863.1| -----
X.fastidiosa 9a5c |NP_299042.1| -----
Acidovorax JS42 |ZP_01382702.1| -----
P.aeruginosa PACS2 |ZP_01366009.1| -----
R.metallidurans CH34 |YP_584510.1| -----
P.aeruginosa 2192 |ZP_00974810.1| -----
P.aeruginosa str.C |AAN62129.1| -----
B.xenovorans LB400 |YP_559832.1| -----
X.c.campestris ATCC33913 |NP_638468.1| -----
N.eutropha C91 |ABI58357.1| -----
X.c.campestris 8004 |YP_243101.1| -----
P.aeruginosa SG17M |AAN62266.1| -----
R.gelatinosus PM1 |ZP_00242313.1| -----
Acidovorax JS42 |ZP_01384808.1| -----
Azoarcus EbN1 |YP_158431.1| -----
Azoarcus EbN1 |YP_158356.1| -----
A.a.citrulli AAC00-1 |ZP_01405034.1| -----
X.a.citri 306 |NP_642513.1| -----
P.aeruginosa PA14 |AAP84130.1| -----MF 2
P.aeruginosa 6077 |ABD94612.1| -----MELPMF 6
P.aeruginosa C pKLC102 |AAP22591.1| -----MF 2
P.aeruginosa C |AAP94681.1| -----
P.aeruginosa 2192 |ZP_00971291.1| -----
A.vinelandii AvOP |ZP_00419624.1| -----M 1
P.fluorescens Pf-5 |YP_261833.1| -----M 1
P.s.phaseolicola |CAI36140.1| -----
P.syringae BR2R |AAL99262.1| -----MGA 3
P.s.tomato DC3000 |NP_790676.1| -----MGT 3
P.s.syringae B728a |YP_233835.1| -----
P.putida F1 |ZP_00898124.1| -----MEGGARVRLSEKAKGFFE 19
P.fluorescens PfO-1 |YP_348763.1| -----
H.influenzae R2866 |ZP_00157643.1| -----
H.influenzae pICEhin1056|CAF29070.1| -----
H.influenzae 86-028NP |YP_247808.1| -----M 1
H.ducreyi 35000HP |NP_873395.1| -----
H.somnus 129PT |YP_718205.1| -----
M.aquaeolei VT8 |ZP_00817690.1| -----M 1
A.a.citrulli AAC00-1 |ZP_01407598.1| -----MDARGRQSRSRPALFHPTAGAGSRHAVNSVAARLLRLLPWSR 42
Azoarcus EbN1 |YP_157225.1| -----MAMLAAG----FLLVAAVLAVWLIWAS 23
E.coli pAPEC-O1-R |ABF67837.1| -----MMNFRALYLICKRILGIFSSQENDATSVMIE 32
S.marcescens R478 |NP_941280.1| -----MMNFRALYLICKRILGIFSSQENDATSVMIE 32
S.typhi R27 |NP_058333.1| -----MNFALFLSMQRVFGIFSRRENDVSELMMK 30
S.e.e.typhi CT18 pHCM1 |NP_569454.1| -----MNFALFLSMQRVFGIFSRRENDVSELMMK 30
N.gonorrhoeae MS11 |AAW83058.1| -----MKTSLLTTASS 11
P.resinovorans pCAR1 |NP_758664.1| MRRSKSRHSFSEPSGNSPSARHLPGGFFSTIKLPENETQGGIPHASFSAHN 50
P.vulgaris UR-75 pRts1 |NP_640161.1| -----
Consensus

P. rettgeri |AAM08003.1| ----MFKNLFFQTKALPELS-----SQLDADI PRYPPFLKGLPAAS 37
V. cholerae MO10 |EAZ47260.1| ----MFKNLFFQAKALPDLS-----SQLDAEIPRYPPFLKGLPAAS 37
V. cholerae |ABA87024.1| ----MFKNLFFQAKALPELS-----SQLDAEIPRYPPFLKGLPAAS 37
Shewanella W3-18-1 |YP_962502.1| ----MFKKLFQAKAIPELS-----SQLDADI PRYPPFLKGLPAAS 37
Y.p. orientalis IP275 |ZP_01175343.1| -MLKALNKLFGGRSGVIETAPSARVLPKLDVEDEEIPRYPPFAKGLPVAP 49
X.c. vesicatoria 85-10 |YP_364087.1| ----MLS----LFQRKRPPVAAAP-----SPPPAIDLPGKGLMRPESAA 36
Acidovorax JS42 |ZP_01384863.1| ----MLS----LFQRKRPPVAAAP-----SPPPAIDLPGKGLMRPESAA 36
X. fastidiosa 9a5c |NP_299042.1| ----MLS----LFQRKRPPVAAATP-----SPAPATDLPGKGLMRPESTA 36
Acidovorax JS42 |ZP_01382702.1| ----MLS----LFQRKRPAVAAAP-----TPPSVTDLPKGLMRPESAA 36
P. aeruginosa PACS2 |ZP_01366009.1| ----MLF----LFQRKRPPVAAAP-----SPAPALDLPKGLLRPESAA 36
R. metallidurans CH34 |YP_584510.1| ---HMLS----LFQRKRPAVATAP-----TPPPASDLPGKGLMRPESAA 86
P. aeruginosa 2192 |ZP_00974810.1| -----MRPESAA 8
P. aeruginosa str.C |AAN62129.1| ----MLS----LFQRKRPAVATAP-----TPPPASDLPGKGLMRPESAA 36
B. xenovorans LB400 |YP_559832.1| ----MLS----LFQRKRPPVASAP-----SPAPSNDLPGKGLRREPESAA 36
X.c. campestris ATCC33913 |NP_638468.1| ----MLR----LFQRK-SAVLPPV-----AAVTETALS KGLLQPKPAE 35
N. eutropha C91 |ABI58357.1| ----MLS----LFQRKRLPTTDM-----AMPSTAPPKGM RPESAA 36
X.c. campestris 8004 |YP_243101.1| ----MLS----LFQRKRASVAAAA-----SPGPTDLPKGLTRPETAAS 36
P. aeruginosa SG17M |AAN62266.1| ----MLS----LLQRKRVSPTAGA-----PATPASDSPKRLTQPESATA 36
R. gelatinosus PM1 |ZP_00242313.1| -----MRPESAA 8
Acidovorax JS42 |ZP_01384808.1| ----MLS----LFQRKRVPPTAGT-----PPTSAIETPKGSM RPESAA 36
Azoarcus EbN1 |YP_158431.1| ----MIS----LFQRKRVPATGA-----PPT-LTEPPKGLMRPASAAS 35
Azoarcus EbN1 |YP_158356.1| ----MLS----LFQRKRVTPTVGA-----PITPPPEAPKGLMG PESAA 36
A.a. citrulli AAC00-1 |ZP_01405034.1| ----MFR----LFRRAGAASTTERTPANAPPVAATTPSLPGWTARQSAE 43
X.a. citri 306 |NP_642513.1| ----MFRFPQLFQRAGRQASTIATTC--PETVPDRGSAPGWRTPLSASE 44
P. aeruginosa PA14 |AAP84130.1| QLLS-----WISRKPSPTPTTKA-----APGGFILPLSSME 33
P. aeruginosa 6077 |ABD94612.1| QLLS-----WISRKPSPTPTTKA-----APGGFIPPLSSME 37
P. aeruginosa C pKLC102 |AAP22591.1| QLLS-----WISRKPSPTPTTKA-----APGVFLPLSSSTE 33
P. aeruginosa C |AAP94681.1| -----ME 2
P. aeruginosa 2192 |ZP_00971291.1| -----ME 2
A. vinelandii AvOP |ZP_00419624.1| SLLT-----WLGRKSAE-PTSEA-----PSQGFHSPARAAV 31
P. fluorescens Pf-5 |YP_261833.1| QILS-----WLSRKPAR-PPSEA-----TAQGFHLPVNAAA 31
P.s. phaseolicola |CAI36140.1| -----
P. syringae BR2R |AAL99262.1| YMLS-----FFTRRKAS-PISSN-----NAAGFFKPESPD 33
P.s. tomato DC3000 |NP_790676.1| SMLS-----FFQRKTS-PTTPS-----NAAGFTKPESADA 33
P.s. syringae B728a |YP_233835.1| -MLS-----FFTRRKAS-PISSN-----AAAGFFKPESPD 29
P. putida F1 |ZP_00898124.1| RKTGTAMKRWWFKPQKGLPEESTP-----AAVGHQPLSAES 56
P. fluorescens PfO-1 |YP_348763.1| ----MLSLFRHKRQKPPPPPTVN-----VAEGLYSIESAHT 32
H. influenzae R2866 |ZP_00157643.1| -----MDDEGWITPFTASE 14
H. influenzae pICEhin1056 |CAF29070.1| ----MLSSIFHKIRGKKQDSL NITSSLNKLNSSFTFKVDDEGWITPFTASE 46
H. influenzae 86-028NP |YP_247808.1| GYFFMFSSIFYRLKGGKQDSFTIP-VLD SHNHSMSKIDSEGWITPFSASE 50
H. ducreyi 35000HP |NP_873395.1| ----MISIFHKILNHKNDKSPPTPIQSQ---QSQTSDGWLTPLSAKA 42
H. somnus 129PT |YP_718205.1| ----MFKSLIQFFKSKSNTS---NIKKENAVQRQERQDIEGWITPYSGQE 43
M. aquaeolei VT8 |ZP_00817690.1| IRPFLVQVSMGFDQNHSAE **DSMFKRLMRK**ELTSSPEPKTPPEYAVALS GKD 51
A.a. citrulli AAC00-1 |ZP_01407598.1| AVAATSPNAGAGAAVTSSGQPPAGDGSAAPTFP RVAGSQPGWLRVLEAEQ 92
Azoarcus EbN1 |YP_157225.1| YHDRSGRRASCPAAPDAAGSPTATAGDAR----ALAASRPGWLQVLDAST 69
E. coli pAPEC-O1-R |ABF67837.1| DISSLSPFAQILGDQKYTVPDHPNPEVLK FIEYPTRP TGIQT FNEQ **SILS** 82
S. marcescens R478 |NP_941280.1| DISSLSPFAQILGDQKYTVPDHPNPEVLK FIEYPTRP TGIQT FNEQ **SILS** 82
S. typhi R27 |NP_058333.1| DAANFS PFAQIIGEQKYTVPDHPNPEVLK FIEYPTRP AGIQT FNEQ **SILS** 80
S.e.e. typhi CT18 pHCM1 |NP_569454.1| DAANFS PFAQIIGEQKYTVPDHPNPEVLK FIEYPTRP AGIQT FNEQ **SILS** 80
N. gonorrhoeae MS11 |AAW83058.1| **IMLVSGSMLYLI**INTRKSTDSVSHN----DEVAHINQNI VNRDRFILNAHE 57
P. resinovorans pCAR1 |NP_758664.1| MAEKRMPPFSFLKRLWPRSERAL TDSFAHPAEQMITP **BEIKRYLE**NHNWRN 100
P. vulgaris UR-75 pRts1 |NP_640161.1| ---MFNRLKTLFSGKRTPKPTVNQI IMPAEVVEALTGSGDILRYPPAELG 47
.....

Consensus

P. rettgeri |AAM08003.1| PEDLQS-----TQ**DELI**AKLRQ-VLGFNQDRDFQRLIQPC 70
V. cholerae MO10 |EAZ47260.1| PEDLQS-----TQ**DELI**AKLRQ-VLGFNLRDFQRLIQPC 70
V. cholerae |ABA87024.1| PEDLQS-----TQ**DELI**AKLRQ-VLGFNQREFQRLIQPC 70
Shewanella W3-18-1 |YP_962502.1| PEELQS-----TQ**DELI**AKLRQ-VLGFNQDRDFQKLIQPC 70
Y.p. orientalis IP275 |ZP_01175343.1| LDKILA-----TQ**AELIEKVRN**-SLGFTVDDFNRLVLPV 82
X.c. vesicatoria 85-10 |YP_364087.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYRAP 68
Acidovorax JS42 |ZP_01384863.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYRAP 68
X. fastidiosa 9a5c |NP_299042.1| LLATP-----RR**QKLM**EHIWQ-HTLSRRQFATLYRAP 68
Acidovorax JS42 |ZP_01382702.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYRAP 68
P. aeruginosa PACS2 |ZP_01366009.1| LLATP-----RR**QKLE**EYIWQ-RTLSRRQFVTTYRTP 68
R. metallidurans CH34 |YP_584510.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFAVLYRAP 118
P. aeruginosa 2192 |ZP_00974810.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFAVLYRAP 40
P. aeruginosa str.C |AAN62129.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFAVLYRAP 68
B. xenovorans LB400 |YP_559832.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYRAP 68
X.c. campestris ATCC33913 |NP_638468.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFHTLYRVP 67
N. eutropha C91 |ABI58357.1| LLATP-----RR**QRL**LEHIWQ-RTLSRRQFASLYRAP 68
X.c. campestris 8004 |YP_243101.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFDTTYRTP 68
P. aeruginosa SG17M |AAN62266.1| LLSTP-----RR**QRL**LEHIWQ-RTLSRRQFTALYLAP 68
R. gelatinosus PM1 |ZP_00242313.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYLAP 40
Acidovorax JS42 |ZP_01384808.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYLAP 68
Azoarcus EbN1 |YP_158431.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYLAP 67
Azoarcus EbN1 |YP_158356.1| LLATP-----RR**QKLE**HIWQ-RTLSRRQFATLYLAP 68
A.a. citrulli AAC00-1 |ZP_01405034.1| LLAPA-----RR**QRL**LEHIWQ-RTLSRAQFDQLYLGP 75
X.a. citri 306 |NP_642513.1| LLAPV-----RR**QQL**LEHIWQ-RTLSRAQFDALYLAP 76
P. aeruginosa PA14 |AAP84130.1| LLGTP-----RR**RQL**LENIWQ-RASLSKQGFEEIYRRP 65
P. aeruginosa 6077 |ABD94612.1| LLGTP-----RR**RQL**LENIWQ-RASLSKQGFEEIYRRP 69
P. aeruginosa C pKLC102 |AAP22591.1| LLDTP-----RR**RQL**LENIWQ-RASLSKQGFEEIYRRP 65
P. aeruginosa C |AAP94681.1| LLGTP-----RR**RQL**LENIWQ-RASLSKQGFEEIYRRP 34
P. aeruginosa 2192 |ZP_00971291.1| LLGTP-----RR**RQL**LENIWQ-RASLSKQGFEEIYRRP 34
A. vinelandii AvOP |ZP_00419624.1| LFDTP-----RR**QH**LENIWQ-RASLSRQFDALYRQP 63
P. fluorescens Pf-5 |YP_261833.1| LLNTP-----RR**QEL**LENIWR-RASLSHQFNTLYRQP 63
P.s. phaseolicola |CAI36140.1| -----MQA 3
P. syringae BR2R |AAL99262.1| LLSSS-----RR**RQL**LENIWQ-RTSLPREQFETLYMQA 65
P.s. tomato DC3000 |NP_790676.1| LLSTP-----RR**RQL**LENIWQ-RTSLPRTQFDTTYVQA 65
P.s. syringae B728a |YP_233835.1| LLSTS-----RR**RQL**LENIWQ-RTSLPREQFEALYMQA 61
P. putida F1 |ZP_00898124.1| LLAAS-----HR**KKLL**ARIWQ-YTALSPQFEQLYLEP 88
P. fluorescens PfO-1 |YP_348763.1| LLAVE-----HR**RQL**LDRIWQ-CTALSHVQFTQFYLN 64
H. influenzae R2866 |ZP_00157643.1| LLNSE-----LR**QKYL**NLLWQ-QVSMTQDMFNELYKKP 46
H. influenzae pICEhin1056 |CAF29070.1| LLNSE-----LR**QKYL**NLLWQ-QVSMTQDMFNELYKKP 78
H. influenzae 86-028NP |YP_247808.1| LLNSE-----LR**QKYL**NLLWQ-QVSMTQDMFNELYKKP 82
H. ducreyi 35000HP |NP_873395.1| LLKTE-----LR**QKYL**NILWQ-QVSMTQDMFNESLYQRP 74
H. somnus 129PT |YP_718205.1| LLNTE-----LR**QH**HLGLLWQ-QVSMTREMFHEHLYQKP 75
M. aquaeolei VT8 |ZP_00817690.1| LLKQP-----KR**TEL**ISRVRK-LFSVTEQVWNKHLYA 83
A.a. citrulli AAC00-1 |ZP_01407598.1| LLTTV-----QA**SRA**IQEIWR-KSNQSRETWERDLLPA 124
Azoarcus EbN1 |YP_157225.1| LIQVC-----**NLAGAL**QQIHR-ESKLSQAVWERDFAPA 101
E. coli pAPEC-O1-R |ABF67837.1| **LYRE**KL-----HSISMMLAISDSDIRDAYTFTNLVLKP 116
S. marcescens R478 |NP_941280.1| **LYRE**KL-----HSISMMLAISDSDIRDAYTFTNLVLKP 116
S. typhi R27 |NP_058333.1| **LYRD**KL-----HSISMMLAISDGDIREDAYTFTNLVLKP 114
S.e.e. typhi CT18 pHCM1 |NP_569454.1| **LYRD**KL-----HSISMMLAISDGDIREDAYTFTNLVLKP 114
N. gonorrhoeae MS11 |AAW83058.1| LIQVLD-----LSPQISGIKMN--LGLSDENWSKDALPF 89
P. resinovorans pCAR1 |NP_758664.1| LRYPPYQEGYPGLVSGQWFMRNQHELFDRIIH-SVGMPPASDLKLYVEPI 149
P. vulgaris UR-75 pRts1 |NP_640161.1| FPAQVPG-----FALLSLQEE**IISKIKR**-ELMIRDAEYDEYIQPM 86
.....

Consensus

P.rettgeri |AAM08003.1|
V.cholerae MO10 |EAZ47260.1|
V.cholerae |ABA87024.1|
Shewanella W3-18-1 |YP_962502.1|
Y.p.orientalis IP275 |ZP_01175343.1|
X.c.vesicatoria 85-10 |YP_364087.1|
Acidovorax JS42 |ZP_01384863.1|
X.fastidiosa 9a5c |NP_299042.1|
Acidovorax JS42 |ZP_01382702.1|
P.aeruginosa PACS2 |ZP_01366009.1|
R.metallidurans CH34 |YP_584510.1|
P.aeruginosa 2192 |ZP_00974810.1|
P.aeruginosa str.C |AAN62129.1|
B.xenovorans LB400 |YP_559832.1|
X.c.campestris ATCC33913 |NP_638468.1|
N.eutropha C91 |ABI58357.1|
X.c.campestris 8004 |YP_243101.1|
P.aeruginosa SG17M |AAN62266.1|
R.gelatinosus PM1 |ZP_00242313.1|
Acidovorax JS42 |ZP_01384808.1|
Azoarcus EbN1 |YP_158431.1|
Azoarcus EbN1 |YP_158356.1|
A.a.citrulli AAC00-1 |ZP_01405034.1|
X.a.citri 306 |NP_642513.1|
P.aeruginosa PA14 |AAP84130.1|
P.aeruginosa 6077 |ABD94612.1|
P.aeruginosa C pKLC102 |AAP22591.1|
P.aeruginosa C |AAP94681.1|
P.aeruginosa 2192 |ZP_00971291.1|
A.vinelandii AvOP |ZP_00419624.1|
P.fluorescens Pf-5 |YP_261833.1|
P.s.phaseolicola |CAI36140.1|
P.syringae BR2R |AAL99262.1|
P.s.tomato DC3000 |NP_790676.1|
P.s.syringae B728a |YP_233835.1|
P.putida F1 |ZP_00898124.1|
P.fluorescens Pf0-1 |YP_348763.1|
H.influenzae R2866 |ZP_00157643.1|
H.influenzae pICEhin1056 |CAF29070.1|
H.influenzae 86-028NP |YP_247808.1|
H.ducreyi 35000HP |NP_873395.1|
H.somnus 129PT |YP_718205.1|
M.aquaeolei VT8 |ZP_00817690.1|
A.a.citrulli AAC00-1 |ZP_01407598.1|
Azoarcus EbN1 |YP_157225.1|
E.coli pAPEC-O1-R |ABF67837.1|
S.marcescens R478 |NP_941280.1|
S.typhi R27 |NP_058333.1|
S.e.e.typhi CT18 pHCM1 |NP_569454.1|
N.gonorrhoeae MS11 |AAW83058.1|
P.resinovorans pCAR1 |NP_758664.1|
P.vulgaris UR-75 pRts1 |NP_640161.1|

Consensus

HD domain consensus

IDHLAAYVHLLPASEHHHSGAGGLLRHSLEVAFWAAQAEGIIFVASGT 120
IDHLAAYVHLLPASEHHHSGAGGLLRHSLEVAFWAAQAEGIIFVASGT 120
IDHLAAYVHLLPASEHHHSGAGGLLRHSLEVAFWAAQAEGIIFVASGT 120
IDHLAAYVHLLPASEHHHSGAGGLLRHSLEVAFWAAQAEGIIFVASGT 120
IQRYAAFVHLLPASEHHHRGAGGLFRHGLEVAFWAAQASESVIFSIEGT 132
LERYAELVQGFPASEAHHHAYLGGMLDHGLEIVAYGLKLRQSHLLPVGAS 118
LERYAELAQGFPASEAHHHAYLGGMLDHGLEIVAYGLKLRQSHLLPVGAS 118
LERYAELVQVFPASEAHHHAYPGGMLDHGLEIVAYSCLKLRQSHLLPIGAT 118
LERYAELVQAFPASEAHHHAYPGGMLDHGLEIVAYSCLKLRQSHLLPIGAS 118
LERYAELVQQFPASEAHHHAYPGGMLDHGLEIVAYSCLKLRQSHLLPIGAS 118
LERYAELVQAFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPIGAS 168
LERYAELVQAFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPIGAS 90
LERYAELVQAFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPIGAS 118
LERYAELVQRFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPAGST 118
LERYADLVQGFPASEAHHHAYLGGMLDHGLEIVAFLKLRQSHLLPAGAS 117
LERYAELVQLFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPAGTT 118
LERYAALVQQFPASEAHHHAYHGGMLDHGLEIVAYALKLRQSYLLPAGAT 118
LERYASLVQGFPASEAHHHAYS GGMLDHGLEIVAYALKLRQSYLLPTGTT 118
LERYAELVQGFPASENHHHAYPGGMLDHGLEIVAYALKLRQSYLLPAGVT 90
LERYAELVQGFPASENHHHAYPGGMLDHGLEIVAYALKLRQSYLLPAGVT 118
LERYVELVQGFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPAGAT 117
LERYAELVQGFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPAGAS 118
IRRYAEFVQSFPASEAHHHAYPGGMLDHGLEIVAYALKLRQSHLLPAGAT 125
IQRYAEMVQLFPASEAHHHAHPGGMLDHGLEIVAYALKLRQSYLLPAGAT 126
LANYAELVQQLPASENHHHAHPGGMIDHGLEIVAYALKVRQTYLLPIGAA 115
LANYAELVQQLPASENHHHAHPGGMIDHGLEIVAYALKVRQTYLLPIGAA 119
LANYAELVQQLPASENHHHAHPGGMIDHGLEIVAYALKVRQTYLLPIGAA 115
LANYAELVQQLPASENHHHAHPGGMIDHGLEIVAYALKVRQTYLLPIGAA 84
LANYAELVQQLPASENHHHAHPGGMIDHGLEIVAYALKVRQTYLLPIGAA 84
LERFAELVQLLPASENHHHAHLGGLLDHGLEIVAYALKIRQTYLLPIGAP 113
LERYAELVQLMPASENHHHAHLGGLLDHGLEIVAYALKIRQTYLLPIGAP 113
FKSYAALVQHLPASENHHHAYHGGMLDHGLEIVAYALKIRQMYLLPIGAP 53
FKSYAALVQHLPASENHHHAYHGGMLDHGLEIVAYALKIRQMYLLPIGAP 115
FKSYAALVQHLPASENHHHAYHGGMLDHGLEIVAYALKIRQMYLLPIGAP 115
FKSYAALVQHLPASENHHHAYHGGMLDHGLEIVAYALKIRQMYLLPIGAP 111
IRRYATYVQQLPASEAHHHAYPGGMLDHGLELVACSLKLRQSYLLPGGAA 138
IHRYAEVQQLPASETHHHAYLGGMLDHGLELVACSLKLRQSYLLPTGAA 114
IERYAEMVQLLPASEAHHHSHLGGMLDHGLEVLVSFAKLRQSYVLPQNAA 96
IERYAEMVQLLPASEAHHHSHLGGMLDHGLEVLVSFAKLRQSYVLPQNAA 128
IERYAEMVQLLPASEAHHHSHLGGMLDHGLEVLVSFAKLRQSYVLPQNAA 132
IERYAEMVQLLPASEAHHHAPLGGMLDHGLEVLVSFAKLRQSYVLPQNAA 124
IERYAEMVQLLPASEAHHHSHLGGMLDHGLEVLVSFAKLRQSYVLPQNAA 125
IEQFAELVQEVPASEIHHHSESGGLIDHTLEALYAGVRISQGYILPPNAE 133
IHRYAEFVQLMPASEAHHHAHAGGLLSHTTEMLLAAMTWRNAHLLPGGSE 174
IGQTLRYVQQLPASEAHHHAHVGGGLAAHTVEVVAHAIAIRNGYLLPRGGA 151
LVEYVRWIHLLPASENHHHNGIGLLSHSLEVAIILSLKNAHSHSELRPIGY 166
LVEYVRWIHLLPASENHHHNGIGLLSHSLEVAIILSLKNAHSHSELRPIGY 166
LIEYIRWIHLLPASENHHHNGIGLLSHSLEVAMISLKNANHSELRPIGY 164
LIEYIRWIHLLPASENHHHNGIGLLSHSLEVAMISLKNANHSELRPIGY 164
LEKYIAFVQRLPASEAHHHAGDGGGLVRHTLDVAALALVASTSQSWPPNAK 139
LVNFAELAHMLPASENHHHSGPGGLLRHSLEVASLTDGCLTAFDFTNET 199
LTNFAFNVHLLPASEFHHHRAQGGLLRHTLEVLVYSIKIAKSEFFDANES 136
LERYAELVQQLPASE.HHHAYPGGMLDHGLEIVAYALKLRQSYLLPIGAT

: ..*** ** * : * :

H.b.....s.h

P.rettgeri |AAM08003.1| LETLS--QWTTNNSIERYFIRWRD-----GRCKRHEQFSILVLNRVMTP 207
V.cholerae MO10 |EAZ47260.1| LETLS--QWTTNNSIERYFIRWRD-----GRCKRHEQFSILVLNRVMTP 207
V.cholerae |ABA87024.1| LETLS--QWTTNNSIERYFIRWRD-----GRCKRHEQFSILVLNRVMTP 207
Shewanella W3-18-1 |YP_962502.1| LETLS--QWTTNNSIERYFIRWRD-----GRCKRHEQFSILVLNRVMTP 207
Y.p.orientalis IP275 |ZP_01175343.1| SESLH--DWAHRHEIDRYFIRWRD-----KRHKRHEQFSLLAVDRIIPA 219
X.c.vesicatoria 85-10 |YP_364087.1| HG-----PLRQPYRFYRDDRE-----YRLHSAATGLLYRQLLDR 197
Acidovorax JS42 |ZP_01384863.1| HG-----PLRQPYRFYRDDRE-----YRLHSAATGLLYRQLLDR 197
X.fastidiosa 9a5c |NP_299042.1| HG-----PLRQPYRFYRDDRE-----YRLHSAATGLLYRQLLDR 197
Acidovorax JS42 |ZP_01382702.1| HG-----PLHQPYRFYRDDRE-----YRLHSAATGLLYRQLLDR 197
P.aeruginosa PACS2 |ZP_01366009.1| HG-----PLLQPYRFYREDRE-----YRLHSAATGLLYRQLLDR 197
R.metallidurans CH34 |YP_584510.1| YG-----PLHQPYRFYRDDRE-----YRLHSAATGLLYRQLLDT 247
P.aeruginosa 2192 |ZP_00974810.1| YG-----PLHQPYRFYRDDRE-----YRLHSAATGLLYRQLLDT 169
P.aeruginosa str.C |AAN62129.1| YG-----PLHQPYRFYRDDRE-----YRLHSAATGLLYRQLLDT 197
B.xenovorans LB400 |YP_559832.1| HG-----PLRQPYRFYREDRE-----YRLHSAATGLLYRQLLDA 197
X.c.campestris ATCC33913 |NP_638468.1| HG-----PLSQPYRFYRHREGRE-----YRLHGAATGLLYSRILDS 196
N.eutropha C91 |ABI58357.1| HG-----PLTRPYRFYREDRE-----YRLHSAATGLLYTRVLGD 197
X.c.campestris 8004 |YP_243101.1| HG-----QLKQPYRFYREDRE-----YRLHSAATGLLYHQVIDR 197
P.aeruginosa SG17M |AAN62266.1| HG-----PLSQPYRFYRQDRE-----YRLHSAATGLLYRQVLDD 197
R.gelatinosus PM1 |ZP_00242313.1| HG-----PLRKPYRFYRKERE-----YRLHSAATGLLYARLLDR 169
Acidovorax JS42 |ZP_01384808.1| HG-----PLRKPYRFYRKERE-----YRLHSAATGLLYARLLDR 197
Azoarcus EbN1 |YP_158431.1| HG-----PLRRPYRFYRTDCE-----YRLHSAAGLLYARLLDP 196
Azoarcus EbN1 |YP_158356.1| HG-----PLRKPYRFYHKARE-----YRLHGAATGLFYTRLLDA 197
A.a.citrulli AAC00-1 |ZP_01405034.1| HG-----VLRYPYRFYRRGRE-----YRLHGAASGLLYLQILDR 204
X.a.citri 306 |NP_642513.1| HG-----VLRQPYRFYRSGRE-----YRLHGAAGLLYARVLD 205
P.aeruginosa PA14 |AAP84130.1| NG-----PINQPYRFKYVKSRE-----YQLHGAASALLIHQLLFR 194
P.aeruginosa 6077 |ABD94612.1| NG-----PINQPYRFKYVKSRE-----YQLHGAASALLIHQLLFR 198
P.aeruginosa C pKLC102 |AAP22591.1| NG-----PINQPYRFKYVKSRE-----YQLHGAASALLIHQLLFR 194
P.aeruginosa C |AAP94681.1| NG-----PINQPYRFKYVKSRE-----YQLHGAASALLIHQLLFR 163
P.aeruginosa 2192 |ZP_00971291.1| NG-----PINQPYRFKYVKSRE-----YQLHGAASALLIHQLLFR 163
A.vinelandii AvOP |ZP_00419624.1| HG-----PITRPFYRFYVKGRE-----YPLHGAASALLYAQILDR 192
P.fluorescens Pf-5 |YP_261833.1| HG-----PIAKPYRFKYIKGRE-----YQLHGAATALIYSQILAP 192
P.s.phaseolicola |CAI36140.1| HG-----PLDQPYRFKYVKGRD-----YRLHGAASLLIYSNVIPA 132
P.syringae BR2R |AAL99262.1| HG-----PLDQPYRFKYVKGRD-----YRLHGAASLLIYSNVIPA 194
P.s.tomato DC3000 |NP_790676.1| HG-----PLDQPYRFKYVKGRD-----YRLHGAASLLIYANVIPA 194
P.s.syringae B728a |YP_233835.1| HG-----PLDQPYRFKYVKGRD-----YRLHGAASLLIYSHVIPA 190
P.putida F1 |ZP_00898124.1| HG-----PLNQPYRFYVPDRD-----YQLHGAAGLLYTQILTP 217
P.fluorescens PfO-1 |YP_348763.1| QG-----SLDQPYRFYIKGRD-----YHLHGAAGLLYTQILDR 193
H.influenzae R2866 |ZP_00157643.1| LG-----IPTLPYKFKYIKGRD-----YELHPVMGSSYLASYLIPK 175
H.influenzae pICEhin1056 |CAF29070.1| LG-----IPTLPYKFKYIKGRD-----YELHPVMGSSYLASYLIPK 207
H.influenzae 86-028NP |YP_247808.1| LG-----VPTQPYKFKYIKGRD-----YDLHPVMGSFLANYLIPK 211
H.ducreyi 35000HP |NP_873395.1| HG-----VPPQPYKFKYIKGRD-----YEFHPVLGSLYAGFLIPQ 203
H.somnus 129PT |YP_718205.1| HG-----IPTLPYKFKYIKQRD-----YELHPVLGGFIANQLIAK 204
M.aquaeolei VT8 |ZP_00817690.1| YGNI-----PPGAAAYRFYFRKIENTRLAKTLHEKSAMSLPRLLSK 223
A.a.citrulli AAC00-1 |ZP_01407598.1| GGSLVQIAGR--PAAEYLVDFAFKSQRD---YSAHGRLAQLLPRIAPE 268
Azoarcus EbN1 |YP_157225.1| AGDMVAAG-----AAEYEVRFAPKAERD---YGAHRRLLPLVLA PRIVPA 241
E.coli pAPEC-O1-R |ABF67837.1| SQS--LLDWARENDVVEYEHWRKR-----IHNQHNIWSSVFLERILNP 254
S.marcescens R478 |NP_941280.1| SQS--LLDWARENDVVEYEHWRKR-----IHNQHNIWSSVFLERILNP 254
S.typhi R27 |NP_058333.1| SQS--LLDWARENNVVEYEHWRKR-----IHNQHNIWSSVFLERILD 252
S.e.e.typhi CT18 pHCM1 |NP_569454.1| SQS--LLDWARENNVVEYEHWRKR-----IHNQHNIWSSVFLERILD 252
N.gonorrhoeae MS11 |AAW83058.1| TGSMAE-----SGKLYRVEFPDAKS----AYSTHAEIAWTFQALVPS 229
P.resinovorans pCAR1 |NP_758664.1| QETLHDWS--VRNKLTRYFLHWNSN-----RHGNHVQVSVQA TRIIPP 286
P.vulgaris UR-75 pRts1 |NP_640161.1| VHCLH--EWAETEKIERYFIFWRS-----DRHERHHNTSLTKMTDIVPK 223
ConsensusPLRQPYRFYRKDRE.....YRLHGAASGLLYRQLLDR

* * *

c . . . s

HD domain consensus

P.rettgeri |AAM08003.1|
V.cholerae MO10 |EAZ47260.1|
V.cholerae |ABA87024.1|
Shewanella W3-18-1 |YP_962502.1|
Y.p.orientalis IP275 |ZP_01175343.1|
X.c.vesicatoria 85-10 |YP_364087.1|
Acidovorax JS42 |ZP_01384863.1|
X.fastidiosa 9a5c |NP_299042.1|
Acidovorax JS42 |ZP_01382702.1|
P.aeruginosa PACS2 |ZP_01366009.1|
R.metallidurans CH34 |YP_584510.1|
P.aeruginosa 2192 |ZP_00974810.1|
P.aeruginosa str.C |AAN62129.1|
B.xenovorans LB400 |YP_559832.1|
*X.c.campestris*ATCC33913|NP_638468.1|
N.eutropha C91 |ABI58357.1|
X.c.campestris 8004 |YP_243101.1|
P.aeruginosa SG17M |AAN62266.1|
R.gelatinosus PM1 |ZP_00242313.1|
Acidovorax JS42 |ZP_01384808.1|
Azoarcus EbN1 |YP_158431.1|
Azoarcus EbN1 |YP_158356.1|
A.a.citrulli AAC00-1 |ZP_01405034.1|
X.a.citri 306 |NP_642513.1|
P.aeruginosa PA14 |AAP84130.1|
P.aeruginosa 6077 |ABD94612.1|
P.aeruginosa C pKLC102 |AAP22591.1|
P.aeruginosa C |AAP94681.1|
P.aeruginosa 2192 |ZP_00971291.1|
A.vinelandii AvOP |ZP_00419624.1|
P.fluorescens Pf-5 |YP_261833.1|
P.s.phaseolicola |CAI36140.1|
P.syringae BR2R |AAL99262.1|
P.s.tomato DC3000 |NP_790676.1|
P.s.syringae B728a |YP_233835.1|
P.putida F1 |ZP_00898124.1|
P.fluorescens PfO-1 |YP_348763.1|
H.influenzae R2866 |ZP_00157643.1|
H.influenzae pICEhin1056|CAF29070.1|
H.influenzae 86-028NP |YP_247808.1|
H.ducreyi 35000HP |NP_873395.1|
H.somnus 129PT |YP_718205.1|
M.aquaeolei VT8 |ZP_00817690.1|
A.a.citrulli AAC00-1 |ZP_01407598.1|
Azoarcus EbN1 |YP_157225.1|
E.coli pAPEC-O1-R |ABF67837.1|
S.marcescens R478 |NP_941280.1|
S.typhi R27 |NP_058333.1|
S.e.e.typhi CT18 pHCM1 |NP_569454.1|
N.gonorrhoeae MS11 |AAW83058.1|
P.resinovorans pCAR1 |NP_758664.1|
P.vulgaris UR-75 pRts1 |NP_640161.1|

Consensus

HD domain consensus

ELLAWLWLTQPG-PEILQAMLEA-----IGNTDLEHVLS----KLVI 242
ELLAWLWLTQPG-PEILQAMLEA-----IGNTDPEHVLS----KLVI 242
ELLAWLWLTQPG-PEILQAMLEA-----IGNTDPEHVLS----KLVI 242
ELLAWLWLTQPG-PEILQAMLEA-----IGNTDPEHVLS----KLVI 242
ETREFLSKSG-PSIMEAMLEA-----ISGTSVNQPVT----KLML 254
DLLDWLSGY--PSLWAPLLYV-----LAGQYEHAGVVG----ELVV 232
DLLDWLSGY--PSLWAPLLYV-----LAGQYEHAGVVG----ELVV 232
DLLDWLSGY--PSLWAPLLYV-----LAGQYEHAGVVG----ELVV 232
DALDWLSGY--PDLWGPLYV-----LAGQYEHAGVVG----ELVV 232
HVLDWLSGY--PALWAPLLYV-----LAGQYEHAGVVG----ELVV 232
QLLDWLSGY--RDLWGPLYV-----LAGQYEHAGVVG----ELVV 282
QLLDWLSGY--RDLWGPLYV-----LAGQYEHAGVVG----ELVV 204
QLLDWLSGY--RDLWGPLYV-----LAGQYEHAGVVG----ELVV 232
QLLDWLSGY--PALWGPLYV-----LAGQYEHAGVVG----ELVV 232
AALDWLSGY--PALWSQLLYV-----LSGQYEHADMLG----ELVV 231
DILDWLNFG--PSLWSALLYV-----LAGQYEHAGVVG----ELVI 232
FILDWLSGF--PSLWAAALYI-----MAGQYEHAGVVG----ELVI 232
RILDWLSRY--PPLWSALLYV-----LAGQYEHAGTGLG----ELVI 232
DIFDWLSGY--PDLWAAALYV-----LAGQYEHAGTGLG----ELVV 204
DIFDWLSGY--PDLWAAALYV-----LAGQYEHAGTGLG----ELVV 232
GIFDWLSGY--PDVWAAALYV-----LAGQYEHAGTGLG----ELVV 231
GIFDWLSGY--PDLWSALLYV-----LAGQYEHAGTGLG----ELVA 232
AILDWLSGY--PDLWRPLYV-----LAGQHEHAGVVG----ELVV 239
GILDWLSGF--PDLWSPLLFV-----LAGQNEHAGVVG----ELVV 240
TALDWLSRF--PELWAQLIYL-----FAGQYEHAGILG----EIIIV 229
TALDWLSRF--PELWAQLIYL-----FAGQYEHAGILG----EIIIV 233
TALDWLSRF--PELWAQLIYL-----FAGQYEHAGILG----EIIIV 229
TALDWLSRF--PELWAQLIYL-----FAGQYEHAGILG----EIIIV 198
TALDWLSRF--PELWAQLIYL-----FAGQYEHAGILG----EIIIV 198
NILDWLSGF--PEPWRLIYA-----LAGQYEHAGILG----EIVV 227
EILDWLCGF--PELWTELIYL-----VAGQFENAGILG----EIVI 227
KALDWLSGF--PELWSQLVFA-----FAGQYEHADILG----EIVS 167
KALDWLSGF--PELWSQLVFT-----FAGQYEHADILG----EIVS 229
KALDWLSGF--PELWTQLVFA-----FAGQYEHADILG----EIVS 229
KALDWLSGF--PELWSQLVFAFAFA----FAGQYEHADILG----EIVS 229
TLLDWLSY--PELWRQLLSL-----LADHYEQAGTGLG----ELVL 252
PILDWLSGF--PPLWASLLYV-----LAGQYERAGVVG----ELVM 228
EAFEWLAGY--PEAFASLMYA-----MANHKDKSGLLS----EIVQ 210
EAFEWLAGY--PEAFASLMYA-----MANHKDKSGLLS----EIVQ 242
EAFAWLAEY--PEAFSALMYA-----MADHKDKAGLLS----EIVQ 246
EAFDWLTQY--PEVFS----- 217
ETFDWLATY--PEVFSALMYA-----MAGHYDKANVLA----EIVQ 239
EAATWLFKD--LELISQLFST-----ISHSTFGQVIA----EIVR 258
SALQFLAYT--PAALDALEKY-----LSGQ-DKDSLVA----QIVK 302
TALAFLARE--PSVMLELQAV-----WSDG-DATSVLT----EIVR 275
VCLAFLDRVKNKERVYSKMITA-----LNVYTDGNDFLS----KCVR 291
VCLAFLDRVKNKERVYSKMITA-----LNVYTDGNDFLS----KCVR 291
VCMSFLDRVKKERVYAKMVTA-----LNVYNDGNDFLS----KCVR 289
VCMSFLDRVKKERVYAKMVTA-----LNVYNDGNDFLS----KCVR 289
HVRQWLATTD--PNLMITLRNY-----LSGKKDGSPLE----QLIK 264
AVQAWLIEGG--HDIYEALDA-----ISGSGSSPLT----ELVK 320
SLLAFLMQEG--NDIYNELTEALAGSNSFRAVTSRNETGTVFKNKIHKIVA 272

..LDWL.....ELVV

:*

.h

..h.

P.rettgeri |AAM08003.1|
V.cholerae MO10 |EAZ47260.1|
V.cholerae |ABA87024.1|
Shewanella W3-18-1 |YP_962502.1|
Y.p.orientalis IP275 |ZP_01175343.1|
X.c.vesicatoria 85-10 |YP_364087.1|
Acidovorax JS42 |ZP_01384863.1|
X.fastidiosa 9a5c |NP_299042.1|
Acidovorax JS42 |ZP_01382702.1|
P.aeruginosa PACS2 |ZP_01366009.1|
R.metallidurans CH34 |YP_584510.1|
P.aeruginosa 2192 |ZP_00974810.1|
P.aeruginosa str.C |AAN62129.1|
B.xenovorans LB400 |YP_559832.1|
*X.c.campestris*ATCC33913|NP_638468.1|
N.eutropha C91 |ABI58357.1|
X.c.campestris 8004 |YP_243101.1|
P.aeruginosa SG17M |AAN62266.1|
R.gelatinosus PM1 |ZP_00242313.1|
Acidovorax JS42 |ZP_01384808.1|
Azoarcus EbN1 |YP_158431.1|
Azoarcus EbN1 |YP_158356.1|
A.a.citrulli AAC00-1 |ZP_01405034.1|
*X.a.citri*_306_NP_642513.1
P.aeruginosa PA14 |AAP84130.1|
P.aeruginosa 6077 |ABD94612.1|
P.aeruginosa C pKLC102 |AAP22591.1|
P.aeruginosa C |AAP94681.1|
P.aeruginosa 2192 |ZP_00971291.1|
A.vinelandii AvOP |ZP_00419624.1|
P.fluorescens Pf-5 |YP_261833.1|
P.s.phaseolicola |CAI36140.1|
P.syringae BR2R |AAL99262.1|
P.s.tomato DC3000 |NP_790676.1|
P.s.syringae B728a |YP_233835.1|
P.putida F1 |ZP_00898124.1|
P.fluorescens PfO-1 |YP_348763.1|
H.influenzae R2866 |ZP_00157643.1|
H.influenzae pICEhin1056|CAF29070.1|
H.influenzae 86-028NP |YP_247808.1|
H.ducreyi 35000HP |NP_873395.1|
H.somnus 129PT |YP_718205.1|
M.aquaeolei VT8 |ZP_00817690.1|
A.a.citrulli AAC00-1 |ZP_01407598.1|
Azoarcus EbN1 |YP_157225.1|
E.coli pAPEC-O1-R |ABF67837.1|
S.marcescens R478 |NP_941280.1|
S.typhi R27 |NP_058333.1|
S.e.e.typhi CT18 pHCM1 |NP_569454.1|
N.gonorrhoeae MS11 |AAW83058.1|
P.resinovorans pCAR1 |NP_758664.1|
P.vulgaris UR-75 pRts1 |NP_640161.1|

Consensus

HD domain consensus

EADQTSVQRDLKAQRISVDDNALG-VPVERYLLDAMRRLASS-QWLVNQ 290
EADQTSVQRDLKAQRISVDDNALG-VPVERYLLDAMRRLASS-QWLVNQ 290
EADQTSVQRDLKAQRISVDDNALG-VPVERYLLDAMRRLASS-QWLVNQ 290
EADQTSVQRDLKAQRISVDDNALG-VPVERYLLDAMRRLASS-QWLVNQ 290
RADQESVSRDLRQSRDLVDEFSYG-VPVERYVFDAIRRLVKTG-KWKVNE 302
QADRASVAQELGGDP-ARAMAAPK-HSLQRKLVNGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HSLQRKLVNGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HSLQRKLVNGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--QLKLNQ 278
QADRASVAQELGGDP-ARVMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 328
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 250
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-ARAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 278
QADRASVAQELGGDP-AKVMAAPK-HALQRKLEGLRYLLKE--QLKLNQ 277
QADRASVAQALGGDP-ARAMAAPK-HALQRKLEGLRYLLKE--ELKLNQ 278
KADRASVAQELGGDP-AKAMAAPK-HALQRKLLDGLRYLLKE--ELKLNQ 278
QADRASVAQALGGDP-ARAMAAPK-HALQRKLEGLRYLLKE--ELKLNQ 278
QADQASVAQELGGDP-SKALAAPK-HALQRKLLDGLRYLLKE--EFKLNQ 250
QADQASVAQELGGDP-SKALAAPK-HALQRKLLDGLRYLLKE--EFKLNQ 278
QADRASVAQELGGDP-GKALAAPR-HALQRKLLDGLRFLLE--EFKLNQ 277
QADQASVAQALGGDP-AKALAAPR-HALQRKLLDGLRYLLKE--EFKLNQ 278
QADQASVAQAMGGDP-ARALAAPR-HALQRKLLDGLRFLLE--QLQLNQ 285
QADQASVAQSLGGDP-AKALTAPR-HALQRKLEGLRYLLRE--QLQINQ 286
KADQASVAQELGGNP-DRALAAPK-QSLQRQLADGLRFLVKD--KFKLNQ 275
KADQASVAQELGGNP-DRALAAPK-QSLQRQLADGLRFLVKD--KFKLNQ 279
KADQASVAQELGGNP-DRALAAPK-QSLQRQLADGLRFLVKD--KFKLNQ 275
KADQASVAQELGGNP-DRALAAPK-QSLQRQLADGLRFLVKD--KFKLNQ 244
KADQASVAQELGGNP-DRALAAPK-QSLQRQLADGLRFLVKD--KFKLNQ 244
KADQASVAQALGGNP-ERALAAPK-QSLQRQLAEGRLYLVR--KFKLNQ 273
KADSASVAQELGGNP-DRAMAAPK-QSLQRQLVECLRYLVR--KFKLNH 273
QADQASVAQELGGNP-GRAMSAPK-QSIQRQLAEGRLVLVAD--KFKLNQ 213
QADQASVAQELGGNP-GRAMSAPK-QSIQRQLAEGRLMLVAD--KFKLNQ 275
QADQASVAQELGGNP-GRAMSAPK-QSIQRQLAEGRLMLISE--KFKLNQ 275
QADQASVAQELGGNP-GKAMSAPK-QSIQRQLAEGRLMLVAD--KFKLNQ 275
QADRVSSTAQNIGANP-TKALQAPK-HSLQHLLMGLRHLVKN--EFKLNQ 298
QADRVSSTAQNIGGNP-SKALQAPI-HSLQHLLISGLRHLVQH--ELKLNQ 274
KADQNSVTLALGGDV-SKLVQKPG-TSFTKQIVMALRYLLEH--KFKINT 256
KADQNSVTLALGGDV-SKLVQKPG-TSFAKQIVMALRYLLEH--KFKINT 288
KADQNSVTLALGGDV-SKLTQKPI-TSFAKQLVMALRHLLQH--KFKINT 292

KADQNSVALALGGDI-TKLVQKPV-ISFAKQLILALRYLISQ--KFKISS 285
AADGASVSKNVGANTGKKADHTNT-IPLYEKLVSLRKLVDNG-DLKRNK 306
RADKLSTQRALLSGHKARFSTAKA-VPLIDLMLQAMAAMLRSGSTLPLNR 351
LADRRSAAASNQQGPRSQFSAATT-VPLIEQLMAAMRLLRQG-GLPLNR 323
TADFYSTGTDLNVLR-DPIMGLRS-NDAAARAISTIKHNFTS---ININN 336
TADFYSTGTDLNVLR-DPIMGLRS-NDAAARAISTIKHNFTS---ININN 336
TSDYYSTGTDLNVLR-DPIMGLRS-NDAAARAIGTIKHNFST---ININN 334
TSDYYSTGTDLNVLR-DPIMGLRS-NDAAARAIGTIKHNFST---ININN 334
NADMTSVSRDLRSGSRQRFSTAKR-KPFIETIMETLKEMLSDR-GVHFSI 312
WADSASTKRDLNRSGNNGGNATG-VPVPRLVSDAMLRLLSDG-TWKINT 368
HADSRSVKQDLQRYSGDAVRASQTGVPVIARIVDAMRLLIKKE-EWKPENQ 321
QADQAS.....

* *

.hd.h.

Fig. S1. CLUSTAL W alignment of the first three-hundred amino acids of proteins in the *Ng* Tral family. The different font colors represent proteins with similar predicted amphipathic α helices at the N-terminus proximal region: bold, green, blue, and magenta. Underlined (red) in *Ng* Tral is the unique N-terminal hydrophobic region, where the black background, white font highlights the N-terminal amphipathic α helix. *Azoarcus* sp. EbN1 (red font) contains an N-terminal transmembrane domain besides the N-terminus proximal amphipathic α helix. The predicted amphipathic α helices of proteins with two at the N-terminus proximal region are highlighted in yellow. It is not clear if *H. somnus* contains an amphipathic α helix since a charged residue (His) is present on the hydrophobic side of the predicted α helix (orange background, black font). Underlined in black is motif I and II of classical relaxases, present only in *E. coli* pAPEC-01-R, *S. marcescens* R478, *S. typhi* R27, and *S. typhi* CT18 pHCM1. Tyr⁹³ and Tyr²⁰¹ (in *N. gonorrhoeae*) are conserved. The His-rich motif, reported as motif III in R27 Tral, is a hallmark of this family of sequence h(Q/H)xhPASExHHHx₃GG(L/M)h, where h is a hydrophobic residue and x is any residue. The consensus sequence of the fifty-four proteins is shown. The consensus amino acid sequence for the HD domain is also shown: (b) big, (s) small, (h) hydrophobic, and (c) charged. The capital letters represent the invariant amino acids.