

Table 1. Oligonucleotides used for sequencing and cloning. ¹

Primer name	Oligonucleotide sequence from 5' to 3'	Target cloning vector	Description
<i>ape2Up</i>	tacgcggc <u>tttacatat</u> ggccaattt ttaaggg	pET30a(+) pET28a(+)	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; <i>Nde</i> I
<i>ape2Dwn</i>	tgatgtg <u>tttgAAGCTT</u> tggctgtgt acttga	pET30a(+) pET28a(+)	Down-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; <i>Hind</i> III
<i>ape2Up(g)</i>	tacgcggc <u>tttacatatg</u> Ggccaatt ttaaaggg	pET30a(+)	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; frame-shift from G insertion at 4th bp; <i>Nde</i> I
<i>ape2-g-removeFwd</i>	gaaggagatatacatatgccaatttt taagggtttggacatg	pACPM17g	Up-stream primer for site-directed mutagenesis of pACPM17g
<i>ape2-g-removeRev</i>	catgtccaaacccttaaaaattggca tagtgtatatctccttc	pACPM17g	Down-stream primer for site-directed mutagenesis of pACPM17g
<i>ape2UppET32</i>	gacgacgacaagat ggc <u>tttattt</u> gccaattttta	pET32 Ek/LIC	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; Ek/LIC overhang
<i>ape2DwnpET32</i>	gaggagaagcccgg t <u>tttggAAGCTT</u> Ttggctgtgt	pET32 Ek/LIC	Down-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; Ek/LIC over-hang ; <i>Hind</i> III
<i>ape2UppBADHisA</i>	taccggc <u>tttactcgag</u> ccaatttt taagg	pBADHis-A	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; <i>Xho</i> I
<i>ape2DwnpBADHisA</i>	tgatgtg <u>tttgAAGCTT</u> tggctgtgt acttga	pBADHis-A	Down-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; <i>Hind</i> III
<i>ape2UppBAD18Cm</i>	actggc <u>tagcaggagga</u> aattcaccat gccaatttttaagggtttggacatga aaaac	pBAD18-Cm	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; RBS ; <i>Nhe</i> I
<i>ape2DwnpBAD18Cm</i>	atcgaagc <u>tttcaATGATGATGATGA</u> TGATG tggctgtgtacttgatggtt cgactcg	pBAD18-Cm	Down-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; His6-Tag/Stop codon ; <i>Hind</i> III
<i>ape2UppACPM19</i>	actgaagc <u>ttaggagga</u> aattcaccat gccaatttttaagggtttggacatga aaaac	pACPM19	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> ; <i>Hind</i> III; RBS

<i>ape2</i> UppACPM20	actgg <u>ctagc</u> aggagga aattcaccat ggtgtgggttcagccaaaaccccatca acgcc	pACPM20	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> encoding an N-terminal 26 amino acid truncation; <i>NheI</i> ; RBS
<i>ape2</i> DwnpACPM19	cgata <u>aagctt</u> tcaatgatgatgatga tgatg tggtgtgtacttgatggttg cgtac	pACPM19 pACPM20	Common down-stream primer for pBAD18-Cm based constructs; <i>Hind III</i> ; Stop, His₆-tag
<i>ape2</i> UppACPM22	actg <u>ctcga</u> gtactggcagcagacc	pACPM22	Up-stream primer for <i>ape2</i> from <i>N. gonorrhoeae</i> encoding an N-terminal 36 amino acid truncation; <i>XhoI</i>
<i>ape2</i> DwnpACPM21	cagta <u>aagctt</u> tcatggctgtgtactt gatggttg	pACPM21 pACPM22	Common down-stream primer for pBADHis-A based constructs; <i>Hind III</i>

¹Incorporated restriction sites are indicated by underlined typeface and new features introduced by the primers are indicated in bold typeface and explained in the description. Mismatches with the template sequence are indicated by capital letters.

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<i>Neisseria gonorrhoeae</i> ApeB (YP_207683)	127	VFFAGDSLMQGVAPFVQKSLKQQYGI	ESANLSKQSTGLS	-YPSFFDWP	K-TIEETLKKHP	-EISVLAV	-FLGPN	PWDF																																			
<i>Neisseria meningitidis</i> NP_284201)	119	VFFAGDSLMQGVAPFVQKSLKQQYGI	SVNLSKQSTGLS	-YPSFFDWP	K-TIEETLKKHP	-EISVLAV	-FLGPN	PWDF																																			
<i>Neisseria lactamica</i> (ZP_03722920)	128	VFFAGDSLMQGVAPFVQKSLKQQYGI	SVNLSKQSTGLS	-YPSFFDWP	K-TVEETLKKHP	-EISVLAV	-FLGPN	PWDF																																			
<i>Neisseria cinerea</i> (ZP_03744458)	120	VFFAGDSLMQGVAPFVQKSLKQQYGI	SVNLSKQSTGLS	-YPKFFDWP	K-TIEETLQKHP	-EISVLAV	-FLGPN	PWDF																																			
<i>Neisseria flavescens</i> (EEG32498)	139	VFFAGDSLMQGVAPFVQKHLKQEYGV	QSVNLSKQSTGLS	-YPNFFDWP	K-TIEQTLQKEP	-DIRVLV	-FLGPN	PWDF																																			
<i>Neisseria subflava</i> (ZP_03750678)	139	VFFAGDSLMQGVAPFVQKHLKQEYGV	QSVNLSKQSTGLS	-YPNFFDWP	K-TIEQTLQKEP	-DIRVLV	-FLGPN	PWDF																																			
<i>Neisseria mucosa</i> (ACDX02000005.1)	143	VFFAGDSMMQGVAPFVERSLKQYGI	QSVNLSKQSTGLS	-YPKFFDWP	N-TIEQTLKQQT	-DIRLLV	-FLGPN	PWDF																																			
<i>Neisseria sicca</i> (EET44325)	143	VFFAGDSMMQGVAPFVERSLKQYGI	QSVNLSKQSTGLS	-YPKFFDWP	N-TIEQTLKQQT	-DIRLLV	-FLGPN	PWDF																																			
<i>Eikenella corrodens</i> (ZP_03713080)	263	VFFAGDSMMEGVAPHVQRWLS	SSQYGIDSLNLSKQSTGLS	-YPSFFDWP	A-TIEKTLREDQ	-KIRLLV	-FLGPN	PWDF																																			
<i>Kingella oralis</i> (ZP_04600983)	143	VFFTGDSLMQGVAPFVQQS	LKQQYGIASINLSKQSTGLS	-YPNFFDWP	L-TIEQTFKENP	-NIRLMV	-FLGPN	PWDF																																			
<i>Enterobacter sakazaki</i> (ABU75604)	161	VLMI	GDSMMEGVAPQIIISL	LKKEHQIESVNLSKR	STGLA	-YPSFFNWP	KTT-ENTLIREP	-DIGLLIV	-FLGPN	PWDM																																	
<i>Citrobacter youngae</i> (ZP_03836338)	161	VLMI	GDSMMEGVAPQIIISL	LKKEHQIGGVNLSKR	STGLA	-YPSFFNWP	KTT-ENALVRE	-DIGLLIV	-FMGPN	PWDM																																	
<i>Pseudomonas entomophila</i> (CAK13547)	158	VFLV	GDSLMQGVAPHLANTL	LRKRYQIRTVNLSKQSTGLA	-YPGFFNWP	K-TVAETLDHEP	-NIRLMV	-FLGPN	PWDM																																		
<i>Pseudomonas fluorescens</i> (YP_262937)	167	VFFV	GDSLMQGVAPHMANTL	LRKRYNVKSLNLSKQSTGLA	-YPSFFNWP	K-TVESTLASNP	-NIRLMV	-FLGPN	PWDM																																		
<i>Proteus mirabilis</i> (YP_002152370)	171	VLFA	GDSMMQGVAPLLKRQL	QTDYNISSIDL	SKQSTGLA	-YPKFFNWP	Q-TIANRLASDD	-SIKLLV	-FLGPN	PWDM																																	
<i>Proteus penneri</i> (EEG87531)	171	VLFA	GDSMMQGVAPLLKRQL	KTDYNISSIDL	SKQSTGLA	-YPRFFNWP	Q-TIATRLASDD	-SIKLLV	-FLGPN	PWDM																																	
<i>Providencia stuartii</i> (ZP_02961974)	172	VLFA	GDSMMQGVAPHVKNML	LKHYNIDSINLSKQSTGLA	-YPRFFNWP	Q-TISKALNDNP	-KIKVLV	-FLGPN	PWDM																																		
<i>Providencia rustigianii</i> (ZP_03315886)	171	VLFA	GDSMMQGIAPHVKNML	LKHYNIDSINLSKQSTGLA	-YPRFFNWP	E-TIAKALNDNP	-NIKVLV	-FLGPN	PWDM																																		
<i>Providencia alcalifaciens</i> (EEB46552)	171	VLFA	GDSMMQGVAPHVKNML	LKHYNIESINLSKQSTGLA	-YPKFFNWP	D-TIAKALNDNP	-NIKVLV	-FLGPN	PWDM																																		
<i>Providencia rettgeri</i> (EEF72588)	171	VLFA	GDSMMQGVAPHVKNML	LKHYNIDSINLSKQSTGLA	-YPRFFNWP	Q-TIAKALNDNP	-NIKVLV	-FLGPN	PWDM																																		
<i>Chromobacterium violaceum</i> (NP903735)	131	VLLA	GDSMMQGVALLHLLP	LFRQHVK	AIDISKQSTGLT	-YPDFFNWP	A-TIAERQLANP	-KTQ	-LIVMFV	GAND	TWDM																																
<i>Photorhabdus luminescens</i> (NP927854)	167	VLFA	GDSMMQGIAPHLKRR	LYQDYSISSINLSKQSTGLA	-YPSFFNWP	E-TINKTLEANH	-DIK	-LVVIFL	GPN	PWDM																																	
<i>Photorhabdus asymbiotica</i> (YP_030042693)	162	VLFA	GDSMMQGIAPHLKRR	LFQDYSISSINLSKQSTGLA	-YPSFFNWP	A-TINKALETNH	-DIK	-LVIIFL	GPN	PWDM																																	
<i>Dickeya zeae</i> (YP_003002389)	143	VLFI	GDSMMEGVAPHVIKML	RDYRSVAGIDLSKR	STGLT	-YPHFFNWP	LILSRELEKRP	--DIGVLV	-FLGPN	PWDM																																	
<i>Campylobacter jejuni</i> (NP281793)	131	FLFI	GDSLMQGVAI	ALNRDLRNLN	-LKVTDLSKQNTGLS	-YKSYFDW	KATNEAFI	-KNS	-NIKYL	VV	-LLGAND	PWDI																															
<i>Campylobacter coli</i> (ZP_00366779)	121	FLFI	GDSLMQGVAI	ALNRDLIDLG	-LKANDLSKQNTGLS	-YKSYFDW	KATKEAFA	-KNP	-NIKYL	VV	-LLGAND	PWDI																															
<i>Campylobacter upsaliensis</i> (ZP_00369961)	119	FLLI	GDSLMQGVAV	ALNKDLKLN	-LKVVDLSKQNTGLS	-YKSYFDW	KATK	-TLQNNK	-KIKYL	VV	-LLGAND	PWDI																															
<i>Campylobacter gracilis</i> (EEV17613)	239	VLFM	GDSLMQYVGMNAK	KFFPKR	-SLRVIDLSKQSTGLA	-SKKSF	DWQK-TLDTALRENG	-GVK	-LVVLL	GAND	VWEY																																
<i>Campylobacter rectus</i> (EEF14732)	181	VILI	GDSIMQGF	GWGFENAL	LKTR-KIAIKNMAK	ASTGLT	-NKKFYD	WSEELKTALANLKER	PQNL	LILALF	GAND	AYS																															
<i>Campylobacter showae</i> (EET79176)	167	IILI	GDSIMQGF	GWGFENAL	KTS-KISIKNMAK	ASTGLT	-NKKFYD	WSEELKAALASLENR	PQNL	LIFALF	GAND	AYS																															
<i>Helicobacter hepaticus</i> (NP860614)	214	VLLI	GDSMMQGVAP	YVLKTFK	KVN-LRGINLSKH	STGLT	-YKHYFN	WEAALKD-TFAKNP	-DIALV	VV	-LGAND	PWGM																															
<i>Helicobacter cinaedi</i> (ABQT01000013)	214	ILLI	GDSMMQGVAP	YLLRFT	FKK-VKIQGINLSKH	STGLT	-YKHYFN	WELATRD-ALEKNP	-HISL	VV	-LGAND	PWSM																															
<i>Helicobacter bilis</i> (ACDN01000074)	214	FLLI	GDSLMQGIGMVL	PRML-QQHGFRT	KNLAKQSTGLT	-YPSFFN	WERATM	Q-AFQQYK	-DIGV	LV	-VVC	-LGAND	PWNM																														
<i>Cardiobacterium hominis</i> (EEV87983)	261	VLLI	GDSMMQSL	APHIQRELL	ARHHIKSINR	GKPSGLR	-YPDYYN	WPEHLAA-QLEENP	-DVRLI	IV	-LGAND	PQDT																															
<i>Zymomonas mobilis</i> (YP162179)	117	VGVF	GDSYGDGL	LWSALYRL	LPAGEYRVL	KFSQOSTG	FTRYQSLNVEE	KAKSD--LVSQ	PVDI	-A-VICF	-GAND	VQGV																															
<i>Treponema pallidum</i> (ACC65548)	165	ILMC	GDSQ	MRYLTGGAL	QVLTSSHV	QIEVTVSS	GFVRTD	-YYHWP	KFLALD	THTQ	QEPYAA	VIMAF	GMDY	QNF																													
<i>Treponema denticola</i> (ASS11853)	251	ILMI	GDSQ	MHSIA	AGFLRL	TGQNSSIR	VKEISVHS	S	GFIRSD	-YYNWP	KLKNV	FEE	SQ	NERY	DI	AVI	-FLG	MND	YQNF																								
<i>Acidophilus cellulolyticus</i> (ABK52233)	91	IVEI	GDSL	GIDLG	YGLRDV	LAETPGI	TILIPA	AYGSS	GLVR	-PEFYD	WQTHL	QELLN	R	YQP	----	LV	IV	FL	GAND	VQNF																							
<i>Methylobacterium populi</i> (ACB61819)	163	IAVF	GDSLAGYL	AKGADDA	FSDNAE	VAVLDR	SKADS	GLVR	KD-LVD	WAK-TAED	FL	KATP	--	KV	S	Y	AL	MMI	G	V	NDR	QAI																					
<i>Methylobacterium extorquens</i> (ABY31658)	167	IQVF	GDSLAGYL	AKGADDA	FSDNAE	VAVLDR	SKADS	GLVR	KD-LVD	WAK-TAED	FL	KATP	--	KV	S	Y	AL	MMI	G	N	D	R	QAI																				
<i>Parvibaculum lavamentivorans</i> (ABS63572)	80	VVVL	GDSL	GDGM	WAGLYH	LRQDKR	FNVI	KKSR	VATG	F	S	RQD	-YYD	W	N	E	A	V	R	--	I	A	E	T	K	-I	D	I	A	V	V	-M	G	T	N	D	R	Q	P				
<i>Lawsonia intracellularis</i> orf (YP_594856)	174	ILII	GDSM	INEGL	GPVL	QKTL	HNQY	PFK	VREG	KYST	GL	LSR	PDY	F	N	W	P	E	L	T	F	L	V	N	K	H	H	-P	K	---	L	I	I	L	C	L	G	A	N	D	A	Q	D

N. gonorrhoeae ApeB PV--GKRYLKFASDEWAQEYLRVDRILEEAHTHRVQV^{VW}LGIPYMKKVKLDGQMRYLDKLLS-EHLKGKIILIPTA--
N. meningitidis orf PV--GKRYLKFASDEWAQEYLRVDRILEEAHTHYVQV^{VW}LGIPYMKKAKLDGQMRYLDKLLS-EY-KGKIILIPTA--
N. lactamica orf PV--GKRYLKFASDEWAQEYLRVDRILEEAARAH^{HV}QV^{VW}LGIPYMKKAKLDGQMRYLDKLLS-EHLEGGKIILIPTA--
N. cinerea orf PV--GKQYLKFASDEWAQEYLRVDRILEEAHTHHVQV^{VW}LGIPYMKKAKLDGQM^HYLDKLLS-EHLEGGKIILIPTA--
N. flavescens orf PM--GKKYLKFASPEWEAEYLNRRVRRILDASSAH^{DV}QV^{VI}WLGIPYMKKAKLNEQMRYLDKILS-GTVSPQAIWLPTD--
N. subflava orf PM--GKKYLKFASPEWEAEYLNRRVRRILDASSAH^{DV}QV^{VI}WLGIPYMKKAKLNEQMRYLDKILS-GTVSPQAIWLPTD--
N. mucosa orf PK--GKKYLKFASPEWSEY^{LS}RVNRILSAAEQH^{HV}QV^{VI}WLGIPYMKQAKLNKQMRYLDKLLADE-ISP^KALWIPTD--
N. sicca orf PK--GKKYLKFASPEWSEY^{LS}RVNRILSAAEQH^{HV}QV^{VI}WLGIPYMKQAKLNKQMRYLDKLLADE-ISP^KALWIPTD--
E. corrodens orf PNPEGRGYLKFQSP^{WE}QVYRQRIERIVTAAKAAD^{VQ}I^IWLGVP^{LM}KSSRLNAQMRYLDSLFASE-LAGKTIWLPTD--
K. oralis orf PNPKGAYLKFQTP^{WE}AEYLNRRVNRILDTAKQ^{HN}AV^{VI}WLGVPYMKKKKLLDDQMRYLDKLFAAH-LKDKVFWIPTA--
E. sakazaki orf PSEQNRHFLKFKSAEWENEYRQRIERILTSAQQRNI^PVIWALLPVMRKS^{KL}NAGVSYLNTLYAE^{EV}SKAGGVTV^{VD}VN--
C. youngae orf PSERNRHF^LKFKSAEWESEYRQRIERILASAQQRNI^PVIWALPVMRKS^{KL}NAGV-----VSNSGGVTV^{VD}VN--
P. entomophila orf PQGKGKPF^LRFKSP^{WE}EVAYRARIDAILEQARA^{HN}VQV^{LV}WGP^{PN}MEKARLSTAMNYLSGLY-QEQTALFQHY^{VS}AN--
P. fluourescens orf PVVKGKPF^LRFKTP^{WE}EAYRQRIDSILDTAQAH^{NV}QV^{VI}WGP^{PN}MEKPKLSTAMAYLSQLYK^{GQ}IEQYHQHY^{VS}AN--
P. mirabilis orf PPDGGRYLKFAS^EAWGTL^YRARIASIIDNARQH^{NV}S^{VI}WIGP^{PN}MRKQKLSQGMAYLNQLY^{REE}EA^{EKT}G^{EI}Y^{LS}VN--
P. penneri orf PPDGGRYLKFAS^EAWESAYRARIASIIENARQ^{NN}V^{TV}WIGP^{PN}MRKQKLSKGMAYLDKLY^{REE}EA^{EKM}G^{EI}Y^{LS}VN--
P. stuartii orf PPDTGYKYV^{FK}SEI^{WE}QVYRSRINDILTTARQ^{HN}VD^{VI}WGP^{PN}MRKSTLSEGM^RFLRS^{SLY}QSEVEN^SG^{EI}Y^{FS}VN--
P. rustigianii orf PPQ^TGYKYV^{FK}SE^{WE}QVYRSRINDILATARQ^{HN}VD^{VI}WGP^{PN}MRKNNLS^DGMK^FLR^{SLY}QSEVE^KY^GEM^YISAN--
P. alcalifaciens orf PPQSGYKYV^{FK}SE^{WE}QTYRSRISEILTTARQ^HQ^{VD}VIWGP^{PN}MRKNTLS^DGMK^FLR^{GLY}QTEVAKY^GEM^YISAN--
P. rettgeri orf PPQ^TGYKYV^{FK}SD-WEKVYRERIG^{DI}ISTARQ^{HN}VD^{VI}WGP^{PN}MRKNTLS^DGMK^FLS^{SLY}QSEVED^NG^{EI}Y^{FS}VN--
C. violaceum orf --VNGNHYIR^FASPD^{WE}QRYRERIRSILASAGKR^{KV}VL^{WL}GLPNMSR^DDKLNDG^{VH}YLNR^{LY}REEVAAG^GGR^FISTR--
P. luminescens orf PPKHGNIY^LKFASPD^WENLYRQRIEM^{VL}TEARN^HGAD^IWVAP^{PN}MRQK^{KL}SANM^{KY}LR^{SLY}QSEVTKAGEI^{YV}SVN--
P. symbiotica orf PPEHGRIY^LKFASPD^WENLYRQRIEM^{VL}TEARN^HGAD^IWVAP^{PN}MRQK^{KL}STSM^{KY}LR^{SLY}QSEVAKAGEI^{YV}SVN--
D. zeae orf P^{SG}NGKN^{FL}KFESPA^{WE}SAYRDRIRSILHSARE^{KR}IS^{VI}WIS^PPNVEN^{KL}NHG^{IN}YIND^LF^ESEV^KAG^{NE}ISIR^{VN}--
C. jejuni orf -KKG^{GN}-YHR^{FG}SL^{SW}ID^IY^{TS}RV^{DE}II^{KI}AK^{KK}H^KAK^VF^{WF}EI^{PP}V^{KK}ED^{LN}KK^IQ^{VL}N^{KI}Y^SDE^{IL}KN^{KE}IF^{INT}K--
C. coli orf -KKG^G-VYHR^{FG}SD^{SW}ID^IY^{TY}RV^{NE}II^{NI}AK^{QH}H^AK^{IL}W^{FE}IP^PV^{KK}NE^{LN}E^{KI}Q^{IL}N^{KI}Y^{SE}E^{IL}KN^KQ^{IF}INTK--
C. upsaliensis orf -KKG^G-IYHR^FNS^{SK}SW^{LE}IY^{TQ}RV^{DE}IL^{KI}AA^{KY}NA^{KV}L^WY^{EI}PP^VKK^{DD}LN^{KK}LS^{VL}N^{QI}Y^SQ^EIL^{KN}K^GIF^{INT}K--
C. gracilis orf -RAG^GK^{TY}-GIKT^{PR}W^{REF}YAS^{RV}REI^YDTA^{HS}H^GAG^VL^{WL}AMP^{CM}Q^KPDF^EE^KT^{QL}LN^{QI}YA-DAS^MAL^{GGY}-FM^Q--
C. rectus orf SYS^FDERT^{LD}DFG^{SE}AW^{RE}AYEG^{RIA}EI^YEIAE^{EH}G^AQ^VW^{VL}GI^{PC}M^KSE^KFD^{KK}M^KAL^NLI^{YK}DA^{AQ}K^YG^{ARY}ID^{IG}--
C. showae orf --TFDE^QAL^{DF}GT^{DA}W^{RE}AYEG^{RIA}EI^YEIAE^{EH}G^AQ^VW^{VL}GI^{PC}M^KSE^KFD^{KK}M^KAL^NLI^{YK}-DS^{AQ}-----
H. hepaticus orf --K--NIS--FK^SVR^{WE}E^{TY}I^QRIE^EIL^{NV}A^{HS}Y^GAR^VW^YEV^{PS}V^SSK^{SL}ND^{KI}V^{YL}NS^{LY}--ERV^VKEE^GEY^{FL}Q--
H. cinaedi orf --KKG---IA^FKS^{PL}W^EE^IY^{TQ}RI^{DE}IL^{QV}AK^{AY}N^VRV^{AW}Y^{EV}PS^VRE^KSLNDK^IM^YLN^{SLY}ES^{AV}K^QSE^{EY}FL^QSN--
H. bilis orf P-----KMR^FGT^{ES}W^EEV^YKN^{RI}Q^{AI}I^{NI}AK^{SH}GT^{QV}V^WY^{AV}P^MT^KNE^TLN^{KK}L^{AY}LN^{TL}Y^Y-Q^VV^SANG^GIF^LTA--
C. hominis orf NPA^{AE}Q^{KL}N^{FG}T^{PE}W^{EN}Y^RGE^{IR}K^{IL}Q^TAA^{AR}G^{AK}T^LW^{IG}P^{LM}K^{AP}K^YSK^{KI}T^{YL}D^{GL}I^{AD}E^{VE}KA^QQ^HY^QNTN--
Z. mobilis orf --LVGH^{HA}AP^{LL}SAE^{WR}Q^{VI}G^DRIE^SF^VS^{ML}R^QK^GIS^{VY}W^{VL}GI^{PV}MR^KAD^FD^{AS}ISS^MNS^FY^{AA}E^{MA}KL^N-VP^FI^{ET}--
T. pallidum orf YDAD^GSLC-VTK^TAR^{WE}RAYEQ^KMRAC^{LN}II^LHT^{VP}K^VY^{LL}GM^PETR^NK^QL^{NE}K^LV^YIE^{HV}---Q^{KK}V^VA^QY^{DP}Q^RV^{RY}
T. denticola orf YAD^{NG}-K^{VL}V^KET^{ED}W^{ES}AY^RDK^VITHL^DVL^FANT^{KK}V^YW^{LG}M^PIVRD-KI----Y^{NA}Q^{LY}I-ED^LQ^{KK}IA^SE^YSS^{II}
A. cellulolyticus orf -FAD^G-R^YE^KF^{GT}PE^WRT^VY^{AA}RV^GAL^MDE^{AV}AG^{GA}Q^{VL}W^{VG}M^PAMRDPA^FDF^FAM^{SEL}D^GIF^RQEA^{AG}R^{AG}V^{RY}F^{AS}R--
M. populi orf --REG^DQ^TVE^TLSD^KW^{REL}Y^GAR^VDA^VV^KV^FAD^HK^VPL^IW^{VL}GP^PVR^{SE}SLSR^DF^{AT}IND^LV^R-ERV^QR^{AG}Q^S-Y^{AE}I^W
M. extorquens orf --REG^DQ^SVE^{AL}SD^KW^{REI}Y^{AA}RV^DE^VAK^VFA^{EH}K^VPL^IW^{VL}GP^PVR^{SE}SLSR^DF^{AA}IND^LV^R-ERV^QR^{AG}Q^SY^{AE}EV^W
P. lavamentivorans orf -VEN^GV^{RY}AL^F-DD^NW^{REV}Y^KRR^VDD^FTAT^LQAT^GARI^YW^LQL^{PV}M^{RS}PR^FG^{AD}M^{AS}F^{NE}I^FE-ER^{AL}ANG^VDF^VRT^EG
L. intracellularis orf -FDD^KN^HRY^HPG^SQ^{EW}KKI^YT^{NR}AK^HLL^{NI}A^TS^QG^{AY}V^IW^{AG}L^PIM^GK^VP^YAT^{RI}Q^YV^{SE}C^QK-KAC^{DE}T^VNT^QF^{ID}T^Q

* *

<i>N. gonorrhoeae</i> ApeB	QTL-S-G-GKG--RYT-DSVNVNGK-PVRYRSK DGIHFTAE GQKLLAEKIMEKIVFEPSTQPSSTQP
<i>N. meningitidis</i> orf	HTL-S-G-GKD--RYT-DSVNVNGK-PVRYRSK DGIHFTAE GQKLLAAKIMEKIVFEPSTQPSSTQP
<i>N. lactamica</i> orf	HTL-S-G-GED--RYT-DSVNVNGK-PVRYRSK DGIHFTAE GQKLLAAKIMEKIVFEPSTQPSSTQP
<i>N. cinerea</i> orf	HTL-S-G-GED--RYT-DSVNVNGK-SVRYRSK DGIHFTAE GQKLLAAKIMEKIVFEPSTQPSAQP
<i>N. flavescens</i> orf	KLL-SNG-AEE---YA-DSVKVDGK-IIRYRSK DGIHFSAE GQKLLAGKIMEKINFTHDTQP
<i>N. subflava</i> orf	KLL-SNG-AEE---YA-DSVKVDGK-IIRYRSK DGIHFSAE GQKLLAGKIMEKINFTHDTQP
<i>N. mucosa</i> orf	KLL-SNG--SDT--YA-DSVNINGK-IIRYRSK DGIHFSAE GQKLLADKIMEKIVFQ
<i>N. sicca</i> orf	KLL-SNG--SDT--YA-DSVNINGK-IIRYRSK DGIHFSAE GQKLLADKIMEKIVFQTTPEMNGEERTEQLSAR
<i>E. corrodens</i> orf	KIM--GG--EDG-QY-RDSIIINGQ-TVRLRSK DGIHFTIK GQQLADQIAGRIDYRANAVAPATPAASETVMASGKS
<i>K. oralis</i> orf	NLL-SNGG--N--EYS-DSVEIGGK-IVRYRSK DGIHFSVE GQKLLAQAIMQKIEFAQP
<i>E. sakazaki</i> orf	N-I-F-GY-KDN-HY-SPNTVVVGK-RMRVRAD DGIHYSPE GQRLIARAILNKIQF
<i>C. youngae</i> orf	T-L-F-GY-KDN-HY-SPNAVIDGK-KMRVRAD DGIHYSPE GQRLIARAILTKIQFPEKNKE
<i>P. entomophila</i> orf	PMFIL-GY-TDE-SYSYTVRTPGK-RVKVRVD DGIHFTIT GQKLIAEQVLSLISFPGLTVTGH
<i>P. fluourescens</i> orf	EIL--GYQSDEFSYY-RTTG-DGK-KVKTRVD DGIHFTTT GQKLIARVLSLINF-PSQQ
<i>P. mirabilis</i> orf	D-----KYEKD--IYS-DYIG-DGSSRVKLRAG DGIHFSLK GQQIIAQQVFSRIHLQKVDDVDDVTDKNMVTNETIN
<i>P. penneri</i> orf	DMF---KYEKD--IYS-DYMG-DGSSRVKLRAG DGIHFSLK GQQIIAQHVFSRIHLQEEESK
<i>P. stuartii</i> orf	DVF---KY-KDL-TYS-DYFG-DDSSKIKLRSG DGIHFS PKGQQAIAEKVFSLIHFEEKEIPEHAEQTASRQIQVSGS
<i>P. rustigianii</i> orf	DVF---KYKND--DYS-DYIG-DGSNAIKLRSG DGIHFS SGKGQQMIAERVFSLIHFEEGDKEPHETE
<i>P. alcalifaciens</i> orf	DVF---KYKND--DYS-DYIG-DGSNAIKLRSG DGIHFS SGKGQQMIAESVFSLIHFEEEDKEPHEAEQPESGQEQATHS
<i>P. rettgeri</i> orf	DVF---KYKGD--TYS-DYIG-DASSTIKLRSG DGIHFS SGKGQQLIAEKVFSLIHFEEEEKEPHETEQTVSS
<i>C. violaceum</i> orf	ETL---GSQDD--SFNKFMTPDQ-GEVAVRTA DGVHFTTR GQQLLARRVLAELRFEQLASSQEATLD
<i>P. luminescens</i> orf	DIF-----KYHANDYS-DYVG-DNSNKIKLRSG DGIHFS SLKGQQTISDNIFSLIKFIQEPAKQENNS
<i>P. asymbiotica</i> orf	NIF-----KYHSDDYS-DYIG-DNSNKIKLRSG DGIHFS SLKGQQAISDNIFSLIEFIQEPAKQNGNA
<i>D. zeae</i> orf	EIF---G--YQREVYSPDME--KNAKAVRI RTDGVHFS SLTGQKMIAERIFSKINVKPSLNEINH
<i>C. jejuni</i> orf	--LFFSVND-EYSAYIKD----ENNRSIKV RTDGVHFTPS GAREMSKLLLEHIKLEENASK
<i>C. coli</i> orf	--LFFSVND-EFSTYIKN----ENNKSIM RTDGIHFTSN GAKEMSKLLLQHITIKEENAN
<i>C. upsaliensis</i> orf	--LFFSKND-AYSAYIKD----ENNKSIM RSDDGVHFTPS GAKEMSKLLLEYIKLKDNNASF
<i>C. gracilis</i> orf	TTPLVCEKGVYKT-Y-----LQSGSKLVRVR QDDGIHMSKE GCEAVAKEILSRIEVE
<i>C. recturs</i> orf	GAIC---KGG---KFLKA----GADKKPL RNDGVHIS SMNGAKKVAVYVVDKLLNGQSDKF
<i>C. showae</i> orf	KYG-ARYIDISGAICDNGKYLKEGADKKPL RKDDGMHIS SMNGAKKIAVYVVDKLLNGQSDNF
<i>H. hepaticus</i> orf	SNI-ITQGG----KYSAFIKNANGK-SVQVRID DGVHFTAR GYQIMANIFLNALEIIPQVKELDVQEDSIHSLPAQDVE
<i>H. cinaedi</i> orf	G-I-VTQGG----KYSAFIKNAKNGK-SVQVRAD DGVHFTTR GYQIMANILLNSLEVLPLENAPQESEF
<i>H. bilis</i> orf	DAI--LHNGKF-SAYIKD---SSGR-SRLV RAQDGIHFTPY GSRLAKTILDRIVL
<i>C. hominis</i> orf	R-LFAKADG---S-YTAFLPDERGK-PVAVR KGDGIHFTGP GKILTRHIEQINP
<i>Z. mobilis</i> orf	RSLTVDENGQYAP-YLMDGTN-DATKMTLM RANDGVHMSMT GYVRLSRGLASQIRHFADQHRPKLPATSSSETASLVASQ
<i>T. pallidum</i> orf	YSLKPIVPGVHGTYASAIRDTHGR-WVHVMHK DGIHYTIE GGAYVMETLLPLILADLERSRHGYMRSSLGSHELPAK
<i>T. denticola</i> orf	LNKSSIAPGEGVP-YTDTVKTAEGK-KIRLMKD DGHYTVS GGEYIMQPFLELLYKDWLEPCTP
<i>A. cellulolyticus</i> orf	PVL---AGPDGG-YAASVTTSSGR-RVVAR APDGVHITF -GTPE-SGATLLAQAVVGALHAAFGLR
<i>M. populi</i> orf	QGF-VDDRNRFTASGPD---VDGQ-EARL RTSDGIHFTAA GSRKIAHFADVELKRLMGEKGGLPSEQPAA
<i>M. extorquens</i> orf	-GF-VDDRNRFTASGPD---VDGQ-EARL RTSDGIHFTAA GSRKVAHFADVELKRLMGEKGGLPSEQPAAAIAATPGE
<i>P. lavamentivorans</i> orf	--LASGADGSY-TAYGED---RFGR-TRLL RAEDGIHFTMA GYELLSGKVADAILADITEATAPRIATTAPVMLRAVEET
<i>L. intracellularis</i> orf	SVLA-TPQGY-TTYTQE-----SNKHIRL RAKDGIVTEA GRLLMNHLMPYIKQSLETITVNTTKDNKQD

Figure 1. Sequence alignment of *N. gonorrhoeae* Ape2/PatB with hypothetical proteins identified in the nucleotide sequence database. The residues in bold face and yellow highlight denote greater than 50% and 80% identity, respectively, while those in red are invariant amongst all sequences. The potential catalytic residues are denoted by the red asterisks. The accession numbers of the hypothetical proteins are provided in parenthesis.

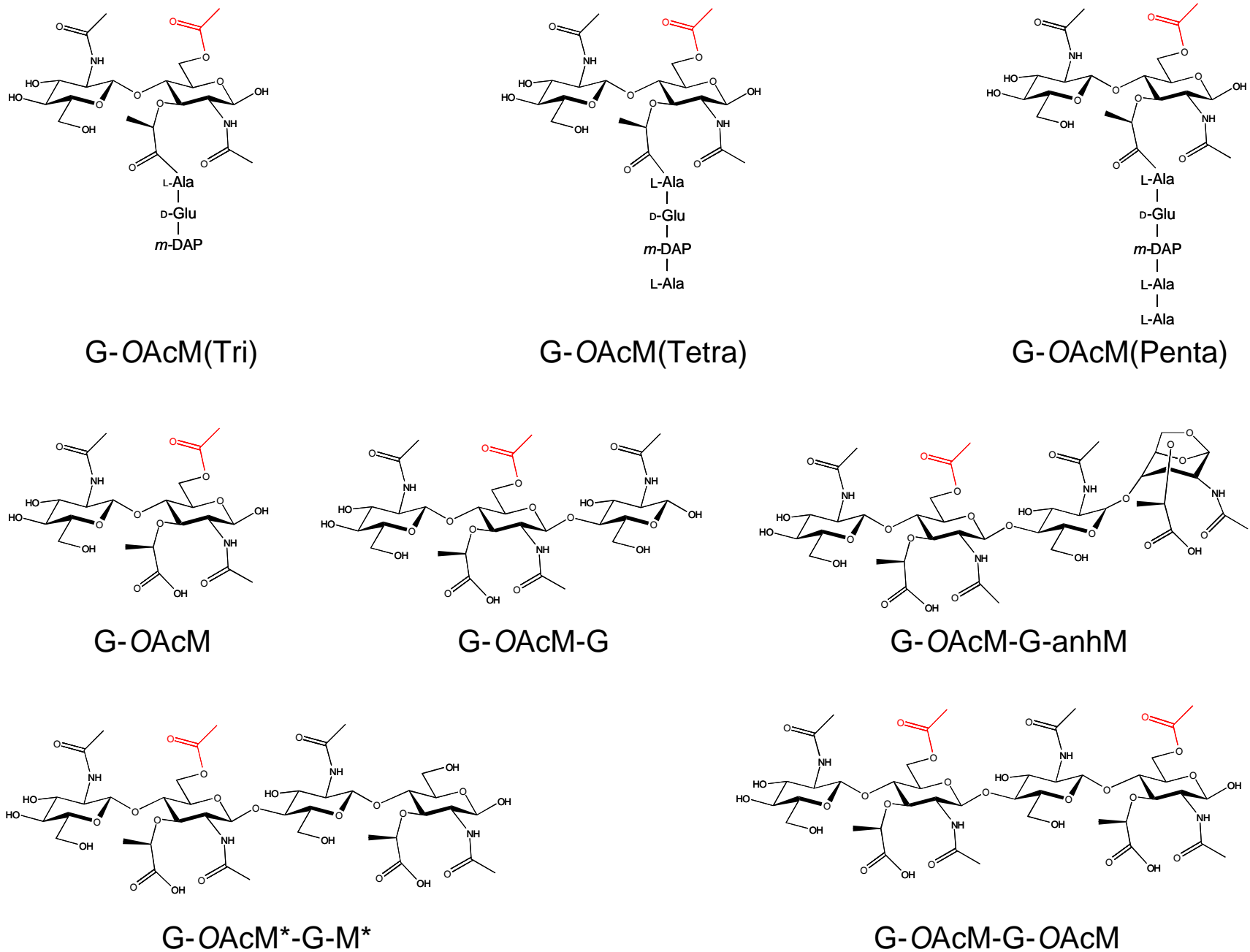


Fig. 2. Structures of unique muropetides and muroglycans identified in PG digests from PatB overproduced in permeabilized cells of *E. coli* Top10[pACPM19]. O-Linked acetate is in red and the asterisks denote that the O-acetate groups could be on either of the MurNAc residues. G, GlcNAc; M, MurNAc; anhM, 1,6-anhydroMurNAc; Tri, tripeptide; Tetra, tetrapeptide; Penta, pentapeptide.