

Supplementary Figure 4: Alignment of Spike protein sequences

	10	20	30	40	50	60	70	80	90	100
HCov-NL63
HCov-229E
PEDV
TGEV
PRCoV
FCoV
CCoV
FIPV

Supplementary Figure 4 (continued)

	910	920	930	940	950	960	970	980	990	1000
HCov-NL63	GNPRCKNLLK	QYTSACKTIE	DALRLSAHLE	TNDVSSMLTF	DSNAFSLANV	TSFG-----D	YNLSSVLPQR	-----	-NIRSSRIAG	RSALIEDLLFS
HCov-229E	GNVRCVELLK	QYTSACKTIE	DALRNSARLE	SADVSEMLTF	DKKAFTLANV	SSFG-----D	YNLSSVIPSL	-----	-PTSGRVAG	RSALIEDLIFS
PEDV	GNSRCKQLLT	QYTAACKTIE	SALQLSARLE	SVEVNSMLTI	SEALQLLATI	SSFNQDGYNF	TNVLGASVYD	-----	-PASGRVVQK	RSVIEDLLFN
TGEV	GNPRCNKLLT	QYVSACQTIE	QALAMGARLE	NMEVDSMLFV	SENALKLASV	EAFNSSETLD	PIYKEWPNIG	GSWLEGLKYI	LPSHNSKRKY	RSALIEDLLFD
PRCoV	GNPRCNKLLT	QYVSACQTIE	QALAMGARLE	NMEVDSMLFV	SENALKLASV	EAFNSSETLD	PIYQWPNIG	GSWLEGLKYI	LPSHNSKRKY	RSALIEDLLFS
FCoV	GNPRCNKLLT	QYVSACQTIE	QALAMGARLE	NMEVDSMLFV	SENALKLASV	EAFNSTENLD	PIYKEWPNIG	GSWLGGLKDI	LPSHNSKRKY	RSALIEDLLFD
CCoV	GNSRCNKLLT	QYVSACKTIE	QALAMGARLE	NMEIDSMLFV	SENALKLASV	EAFNSTDNLD	PIYKEWPNIG	GSWLGGLKDI	LPSHNSKRKY	RSALIEDLLFD
FIPV	GNTHCLKLLT	QYTSACQTIE	NALNLGARLE	SLMLNDMITV	SDRGLELATV	ERFNATALGG	EKLGGLYPDG	-----L	SSLLPKIGK	RSAVEDLLFN

	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100
HCov-NL63	KVVTSGLGTV	DVDYKCKCTG	LSIADLACAQ	YYNGIMVLPG	VADAERMAMY	TGSLIGGMVL	GGLTS-AAAI	PFSLALQARL	NYVALQTDVL	QENQKILAAAS
HCov-229E	KLVTSGLGTV	DADYKCKCTG	LSIADLACAQ	YYNGIMVLPG	VADAERMAMY	TGSLIGGIAL	GGLTS-AVSI	PFSLAIQARL	NYVALQTDVL	QENQKILAAAS
PEDV	KVVTNGLGTV	DEDYKRCNSG	RSVADLVCAQ	YYSGVMLVPG	VVDAEKLHMY	SASLIGGMAL	GGITA-AAAL	PFYSYAVQARL	NYVALQTDVL	QRNQQLLAAS
TGEV	KVVTSGLGTV	DEDYKRCCTG	YDIADLVCAQ	YYNGIMVLPG	VANADKMTMY	TASLAGGITL	GALGGGAVAI	PFYAVAVQARL	NYVALQTDVL	NKNQKILASA
PRCoV	KVVTSGLGTV	DEDYKRCCTG	YDIADLVCAQ	YYNGIMVLPG	VANADKMTMY	TASLAGGITL	GAPGGGAVSI	PFYAVAVQARL	NYVALQTDVL	NKNQKILASA
FCoV	KAVTSGLGTV	DEDYKRCCTG	YDIADLVCAQ	YYNGIMVLPG	VANADKMTMY	TASLAGGITL	GALGGGAVAI	PFYAVAVQARL	NYVALQTDVL	NKNQKILANA
CCoV	KVVTSGLGTV	DEDYKRCCTG	YDIADLVCAQ	YYNGIMVLPG	VANADKMTMY	TASLAGGITL	GALGGGAVSI	PFYAVAVQARL	NYVALQTDVL	NKNQKILANA
FIPV	KVVTSGLGTV	DDDYKCCSSG	TDVADLVCAQ	YYNGIMVLPG	VVDGNKMSMY	TASLIGGMAL	GSITS-AVAV	PFAMQVQARL	NYVALQTDVL	QENQKILANA

	1110	1120	1130	1140	1150	1160	1170	1180	1190	1200
HCov-NL63	FNKAINMIVA	SPSSVNDAIT	QTAEAIHTVT	IALNKIQDVF	NOQGSALNHL	TSQLRHNFOA	ISNSIQAIYD	RLDISIADQQ	VDRLITGRILA	ALNAFVSVQL
HCov-229E	FNKAMTNIIVD	AFTGVNDAIT	QTSQALQTV	TALNKIQDVF	NOQGSALNHL	TSQLRQNFQA	ISSSIQAIYD	RLDTIQADQQ	VDRLITGRILA	ALMVFVSHTL
PEDV	FNSAIEGNITV	AFESVKEAIS	QTSKGLNTVA	HALTRVQEVV	NSQGSALNQL	TVQLQHNFOA	ISSSIDDIYS	RDLILSADVQ	VDRLITGRILA	ALMVFVSVQL
TGEV	FNQAIIGNITQ	SFGKVNDAIH	QTSRGLATVA	KALAKVQDVF	NIQQQALSHL	TVQLQNNFOA	ISSSISDIYN	RDELSDADAQ	VDRLITGRILT	ALMVFVSVQL
PRCoV	FNQAIIGNITQ	SFGKVNDAIH	QTSRGLTVA	KALAKVQDVF	NIQQQALSHL	TVQLQNNFOA	ISSSISDIYN	RDELSDADAQ	VDRLITGRILT	ALMVFVSVQL
FCoV	FNQAIIGNITQ	AFGKVNDAIH	QTSKGLATVA	KALAKVQDVF	NIQQQALSHL	TVQLQNNFOA	ISSSISDIYN	RDELSDADAQ	VDRLITGRILT	ALMVFVSVQL
CCoV	FNQAIIGNITQ	AFGKVNDAIH	QTSKGLATVA	KALAKVQDVF	NIQQQALSHL	TVQLQNNFOA	ISSSISDIYN	RDELSDADAQ	VDRLITGRILT	ALMVFVSVQL
FIPV	FNNAIGNITL	ALGKVSNAIT	TTSDFGNSMA	SALTKIQSVV	NOQGEALSQ	TSQLQKNFOA	ISSSIAEYIN	RLEKVEADAQ	VDRLITGRILA	ALMVFVSVQL

	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300
HCov-NL63	NKYTEVRGSR	RLAQKKNVNEC	VKSQSNRYGF	CG-NGTHLFS	IVNSAPDGLL	FLHTVLLPTD	YKNVKAWSGI	CVDGIYGYVL	RQP-----N	LVLYSDNGVVF
HCov-229E	TKYTEVRASR	QLAQKKNVNEC	VKSQSKRYGF	CG-NGTHLFS	IVNSAPEGLV	FLHTVLLPTQ	YKDVAEASGL	CVDGTNGYVL	RQP-----N	LALYKEGNYFY
PEDV	TKYTEVQASR	KLAQKKNVNEC	VKSQSQRVGF	CGDGEHIFS	LVQAAPQGLL	FLHTVLLVPGD	FVNVLAIAGL	CVNGEIALTL	REPGLVLFTH	ELQTYTATEY
TGEV	TRQAEVRASR	QLAKDKVNEC	VRSQSQRVGF	CG-NGTHLFS	LANAAPNGMI	FFHTVLLPTA	YETVTAWSGI	CASDGRFTFG	LVVKDVQLTL	FRNLDD--KF
PRCoV	TRQAEVRASR	QLAKDKVNEC	VRSQSQRVGF	CG-NGTHLFS	LANAAPNGMI	FFHTVLLPTA	YETVTAWSGI	CALDGRFTFG	LVVKDVQLTL	FRNLDD--KF
FCoV	TRQAEVRASR	QLAKDKVNEC	VRSQSQRVGF	CG-NGTHLFS	LANAAPNGMI	FFHTVLLPTA	YETVTAWSGI	CASDGRFTFG	LVVKDVQLTL	FRNLDD--KF
CCoV	TRQAEVRASR	QLAKDKVNEC	VRSQSQRVGF	CG-NGTHLFS	LANAAPNGMI	FFHTVLLPTA	YETVTAWSGI	CASDGRFTFG	LVVKDVQLTL	FRNLDD--KF
FIPV	TQYAEVKASR	QALAKKNVNEC	VKSQSNRYGF	CG-NGTHLFS	LVNSAPEGLL	FFHTVLLPTE	WEVTAWSGI	CVNDTYAYVL	KDFDHSIFS	NG-----TY

	1310	1320	1330	1340	1350	1360	1370	1380	1390	1400
HCov-NL63	RVTSRVMFQP	RLPVLSDVQ	IYNCNVTFVN	ISRVELHTVI	PDYIDVKNKL	QEFQNLKPK-	--YVKPNFDL	TPFNLTYLNL	SSELKQLEAK	TASLPQTIVE
HCov-229E	RITSRIMPEP	RIPTMADFVQ	IENCNVTFVN	ISRSELQTVI	PEYIDVKNKL	QELSXYLKN-	--YTVPDLVV	EQYNTIILNL	TSEISTLENK	SABLNTYVQK
PEDV	FVSSRRMPEP	RKPTVSDVQ	IESCVVTVVN	LTSQDLDPVI	PDYIDVKNKL	DEILASLKN-	--RTGSPSLP	DVFNATYLNL	TGEIADLEQR	SESLRNTTEE
TGEV	YLTPTRMYPQ	RVATSSDFVQ	IEGCDVLFVN	ATVSDLPSII	PDYIDINQTV	QDILENFRP-	-NWTVPELTF	DIFNATYLNL	TGEIADLEQR	SESLRNTTEE
PRCoV	YLTPTRMYPQ	RVATSSDFVQ	IEGCDVLFVN	TTVSDLPSII	PDYIDINQTV	QDILENFRP-	-NWTVPELTL	DVFNATYLNL	TGEIADLEQR	SESLRNTTEE
FCoV	YLTPTRMYPQ	RAATSSDFVQ	IEGCDVLFVN	ATVIDLPSII	PDYIDINQTV	QDILENFRP-	-NWTVPELTL	DIFNATYLNL	TGEIADLEQR	SESLRNTTEE
CCoV	YLTPTRMYPQ	RVATSSDFVQ	IEGCDVLFVN	ATVIELPSII	PDYIDINQTV	QDILENFRP-	-NWTVPELPL	DIFNATYLNL	TGEIADLEQR	SESLRNTTEE
FIPV	MVTPRMFQP	RKQMSDFVQ	ITSCEVTFLN	MTYTFQEIV	IDYIDINKTI	ADMLEQYNFN	YTPPELNLLL	DIFNQTKLNL	TAEIDLEQR	ADNLTTIAHE

	1410	1420	1430	1440	1450	1460	1470	1480	
HCov-NL63	LQGLIDQINS	TYVDLKLNNR	FENYIKWPWW	VWLIISVVVF	VLLSLLVFCC	LSTGCCGCCN	CLTSSMRGCC	DCGSTKLPYY	EFEKVVHQ
HCov-229E	LQTLIDNINS	TLVDLKLNNR	VETYIKWPWW	VWLCISVVLV	FVVSMLLLCC	CSTGCCGFFS	CFASSIRGCC	ESTKLPYYDV	EKI--HIQ
PEDV	LRLSLINNIN	TLVDLEWLN	VETYIKWPWW	VWLIIVIVL	FVVSLLVFCC	ISTGCCGCCG	CCGACFSGCC	RGPRLPQYEA	FEK--VHVQ
TGEV	LAILIDNINN	TLVNLWLN	IETYVKWPWW	VWLLIGLVVI	FCIPLLLFCC	CSTGCCGCGI	CLGSCCHSIC	SRRQFENYEP	IEK--VHVH
PRCoV	LAILIDNINN	TLVNLWLN	IETYVKWPWW	VWLLIGLVVI	FCIPLLLFCC	CSTGCCGCGI	CLGSCCHSIF	SRRQFENYEP	IEK--VHVH
FCoV	LAILIDNINN	TLVNLWLN	IETYVKWPWW	VWLLIGLVVI	FCIPLLLFCC	CSTGCCGCGI	CLGSCCHSMC	SRRQFENYEP	IEK--VHVH
CCoV	LATLIDNINN	TLVNLWLN	IETYVKWPWW	VWLLIGLVVI	FCIPLLLFCC	CSTGCCGCGI	CIGSCCHSMC	SRRQFESYEP	IEK--VHVH
FIPV	LQQYIDNLNK	TLVDLDLWLN	IETYVKWPWW	VWLLIGLVVV	FCIPLLLFCC	LSTGFCCGCG	CVGSCCHSLC	SRRQFETYEP	IEK--VHIH

Supplementary Fig. 4: Alignment of the sequence of the deduced Spike protein of the group 1 coronaviruses. The GenBank accession numbers of the sequences are provided in the

Supplementary Methods online.