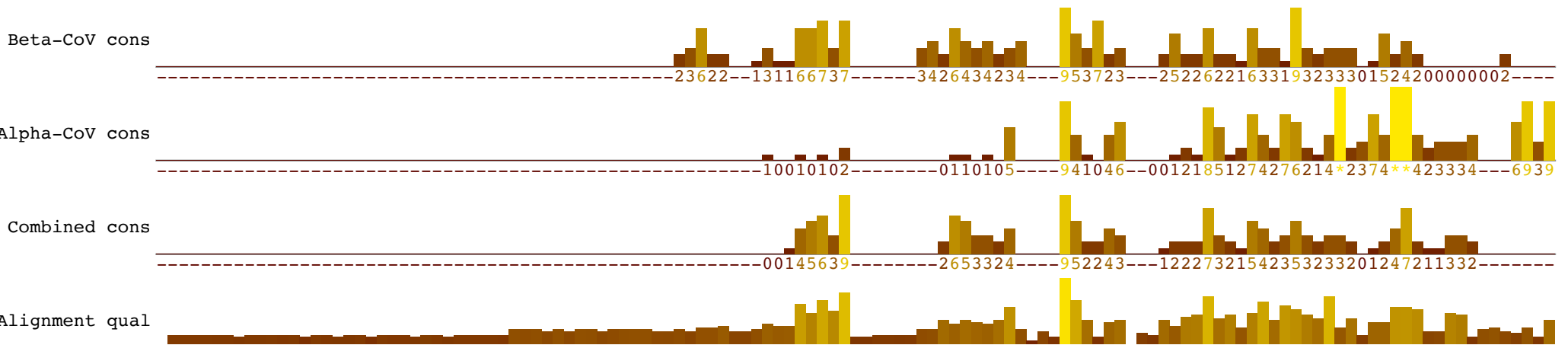
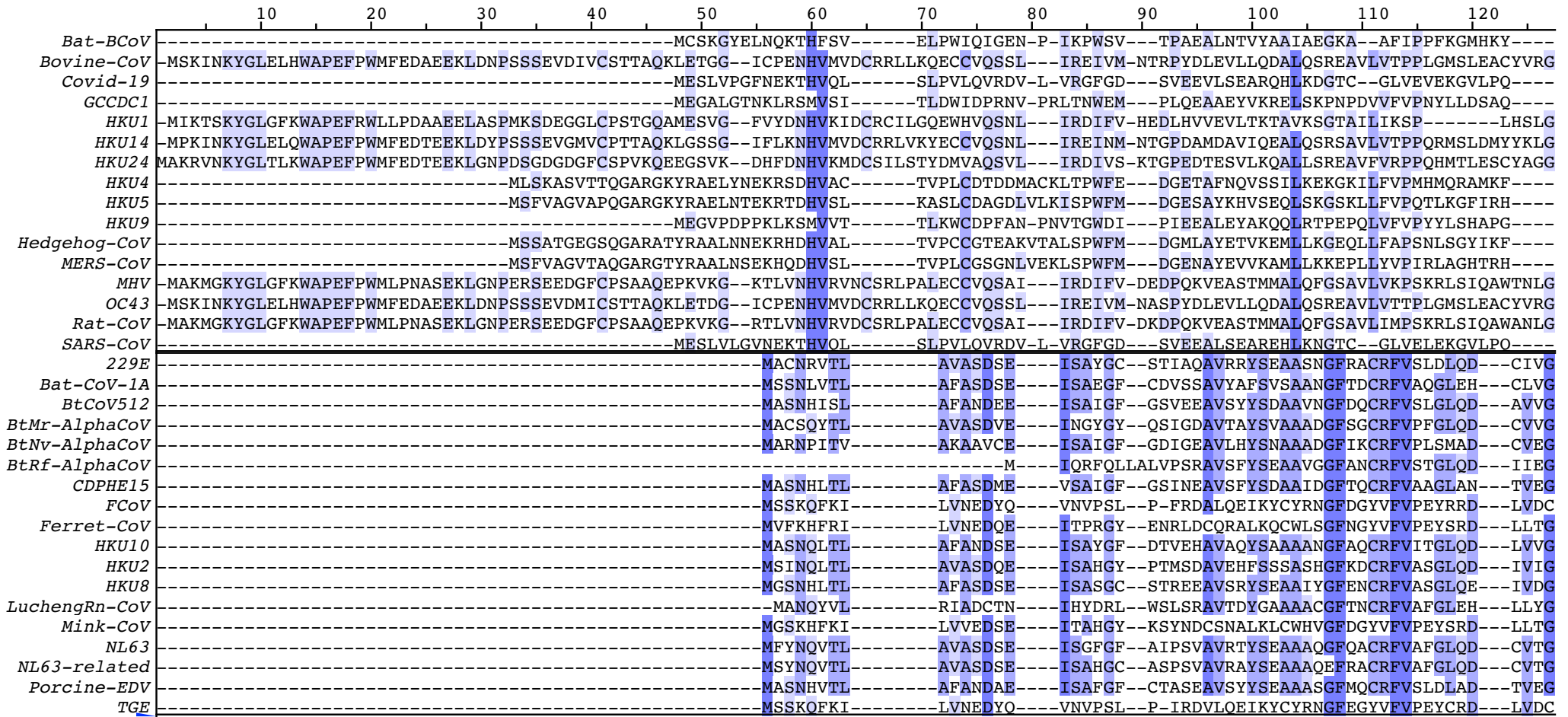


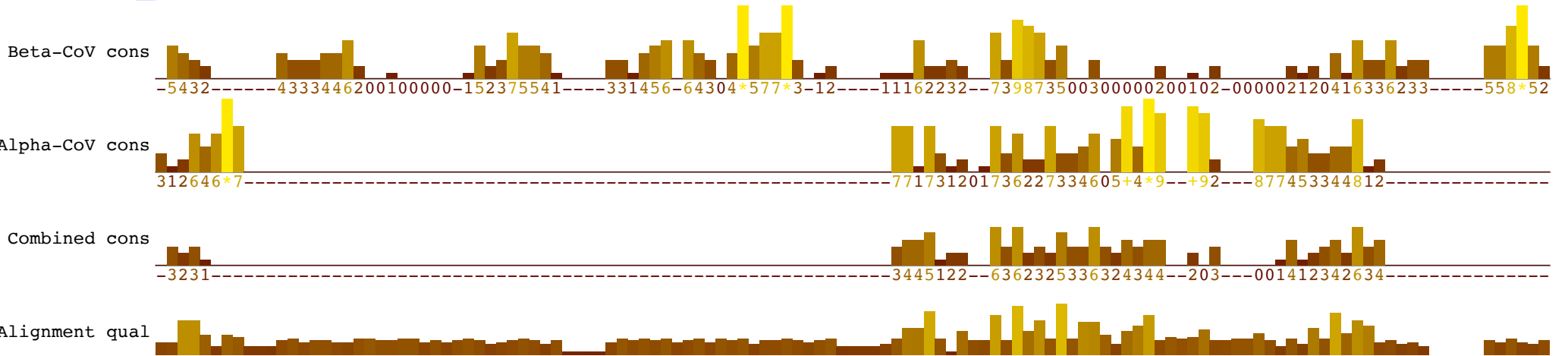
ORF1ab polyprotein





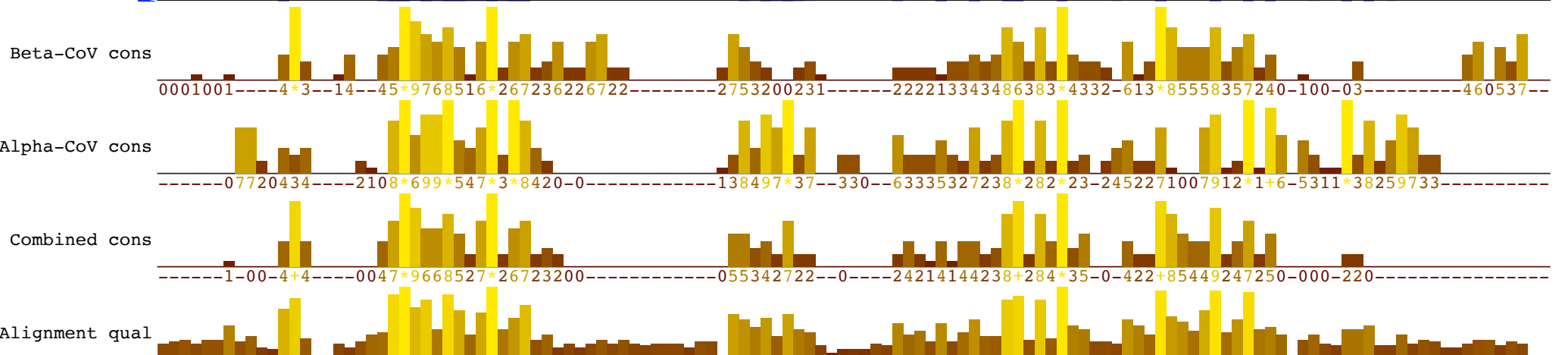
130 140 150 160 170 180 190 200 210 220 230 240 250

Bat-BCoV -LPEL-----CVFLVRNHGNPT-RPF-DLQELAVRE----GDVNYGRSGETVGAIVL-DG----QEPYGTIT--IQLRRRGKNAGGVYAW--TNTRDTVTDDLVEPIDLYTED-----PKGKHA
Bovine-CoV CNPNGWTMGLFRRRSVCNTGRCAVNKHVAYQLYMIDP---AGVCFG--AGQFVGVWVPLAFMPVQSRKFIVPWV--MYLRKCGEKGAYNKDHKRGGF-EHVYNFKVEDAYDLVHDE-----PKGKFS
Covid-19 -LEQP-----YVFIKRS DARTAPHGH-VMVELVAEL---EGIQYGRSGETLGVLPVPH-VG---EIPVAYRK--VLLRKNNGKAGGHSYGADLKSFDLGDDELGTDPYEDFQEN-----WNTKHS
GCCDC1 -IPQN-----RVVITNSVWRRCYEMGWKPVREIAFDL----DGVRFGRGGT-HGVLLPRQPP---QYICGTVS--IELRKYGVGGGAEIFIP-KLWDGFVDPAPAAAEVYLDFFPKCFPTKPKAKR-
HKU1 GFPGKYVMGLFRSYKTKRY-----VVHLSMTT---ST-TNF-GEDFLGWIVPFGFMPYSVHKWFQFCR--LYIEESD-----LIISNFKFDYDFSVEDAYAEVHAE-----PKGKYS
HKU14 CCPKGWTMGLFRRHCQCRGTGNCNVETHVANQLYMIDP---EGVCLG--AGTFIGWFVPLFALPECVRDKTFPWV--LYLRKHGEKGAHSGKHGDT-F-YVDYDFDVEDAYEEVHDN-----PKGKYS
HKU24 CVPKGWVMQFRRCCTCSTGNCVGDVHVSLEYLISP---QGVGYG--AGRFMGWVVPKSVLPPKALARLEPYV--LKRKRTGVKGAYSRGRHYEQ-Q-GAGSSFVLDNACDEVMSA-----PKGKFS
HKU4 -LPGP-----RVYLVERLTGGMLSKHFLVNQLAYKDVGAAMMRTLNAPLGMFFPY-DS---SLETGEYT--FLLRKNGLGGQLFRERPWDRKE-----TPYVEILDLEAD-----PTGKYS
HKU5 -LPGP-----RVYLVERLTGGTYSDPFMVNQLAYQNAAGEGVIGTTLQGKRVGMFFPY-DA---DLVTGEFQ--FLLRKKGFGRNRFRDAPWDYNW-----TPYSDLMDALEAD-----PCGKYS
HKU9 -ISGD-----RVVITDSIWIYATNFGWQPIRELAMDK---DGVRYGRGGT-HGVLLPMQDP---SFIMGDID--IQIRKYGIGANSPPDVL-PLWDGFSDPGDVGVPLDFPDNCCPTKPKAKR-
Hedgehog-CoV -LPGP-----RVYLVERLTGGTYSEPFIVNQLAFSDEQDGPMMGTTLQGKPIGFFPY-DE---ELVTGTYT--FKLRKNGLGGQLFREVPWFENHDFHGIIEGFSQIVEDLQED-----PKGKFS
MERS-CoV -LPGP-----RVYLVERLIA--CENPFMVNQLAYSSANGSLVGTTLQGKPIGFFPY-DI---ELVTGKQN--ILLRKYGRGGYHYTPFFHYERDN-----TSCPEWMDDFEAD-----PKGKYA
MHV VLPKTAAMGLFKRVCLCNTRECSDAHVAFLFTVQP---DGVCLG--NGRFIGWFVPTAIPYAKQWLQPS--ILLRKGNGKGSVTSGHFRRAVTMPVYDFNVEDACEEVHLN-----PKGKYS
OC43 CNPKGWTMGLFRRRSVCNTGRCTVNKHVAYQLYMIDP---AGVCLG--AGQFVGVWVPLAFMPVQSRKFIVPWV--MYLRKRGEKGAYNKDHGRRGF-GHVYDFKVEDAYDQVHDE-----PKGKFS
Rat-CoV VLPRTAMGLFKRVCLCNTRGCSVDHVAFLFTVQP---DGVCLG--NGRFIGWFVPTAIPYAKQWLQPS--ILLRKGNGKGSVTSGH-RRAVTMPVYDFNVEDACEEVHLN-----PKGKYS
SARS-CoV -LEQP-----YVFIKRS DALSTNHGH-KVVELVAEM---DGIOYGRSGITLGVLPVPH-VG---ETPIAYRN--VLLRKNNGKAGGHSYGIDLKSYDLGDELGTDPIDYEON-----WNTKHG
229E IADDTYVM-----GLHGNQTLFCNIMKFSDRPFMLHGW--LVF---SNSNYLLEEFDV-----
Bat-CoV-1A IEADDYVL-----CVTGDVQLKAYIAKFSDRPLNLRGW--IVR---SNSNYFLETMDL-----
BtCoV512 VEDDDVVM-----LITGVTQLRAYLGTFFGDRPLNLRGW--LLF---SNCNYFLEEELDL-----
BtMr-AlphaCoV VNDDDYVM-----VLTGDHTLYAFDLFSATPSNIRGW--LIF---SNCNYVLESFDV-----
BtNv-AlphaCoV LLSDEFVV-----LVNNDTS-CLTVGTFFGERPDLKGW--LLF---SNCVDVGTAI-----
BtRf-AlphaCoV VLDDDYVL-----VITGVHQLVARIQGFQDQPSNLRGW--LLF---SNSNYFLGELDL-----
CDPHE15 VEPSDFVM-----VVTGVTQLRAYIDTFGSRPANLRGW--LLF---SNSNYFLSEMEL-----
FCoV NRKDHYVI-----GVLNGISDLKPVLLTEPSVMLQGF--IVR---ANCVGLEDFDL-----
Ferret-CoV CREQYVVF-----GVFGANDYVIKPCMLEEQSVNLQGF--IVL---SDANGVEEDFYI-----
HKU10 VNDEFVVL-----VVTGLHQLTARIGKFGDQPNLRGW--LLF---SNSNYFLGELDL-----
HKU2 VEPSDFVV-----ALEGDEILTAYIATFGARPCLRGW--LIP---SNSNYVLEEFHV-----
HKU8 VSADDYVL-----CFSGVTTLRAFVGKYGDRPRNLRGW--LLF---SNCNYFLEEIDV-----
LuchengRn-CoV YDDEHWVL-----ILSGNQVLNVELGQFKDRPDNICGY--LVI---SDCTYFEETFDL-----
Mink-CoV CREQEYVF-----GVFGANDNVIKPCFLDVQNTANLQGF--IVR---SSAIGVEEDFYI-----
NL63 INDDDYVI-----ALTGTNQLCAKILPFSDRPLNLRGW--LIF---SNSNYVLQDFDV-----
NL63-related VHDDDYVI-----ALTGTNLLCAKIRPFSDRPRNLRGW--LVF---SNSNYVLEQFV-----
Porcine-EDV LLPEDYVM-----VVIGTTKLSAYVDTEFGSRPRNICGW--LLF---SNCNYFLEELEI-----
TGE DRKDHYVI-----GVLNGVSDLKPVLLTEPSVMLQGF--IVR---ANCVGLEDFDL-----



260 270 280 290 300 310 320 330 340 350 360 370 380

Bat-BCoV QGNLRKFLT--GGN--DFHRYVDNYCTGDKPLPCIVTLLKAGHANKPLDDAMDYLRG--LNRMGQPCRDHHERVVEVERDNAP--YPEQSLFSSISA IKT-----LGE-----IPHCVF--
Bovine-CoV KKAYALI-RGYRGV--KPLLYVDQYGC DYTGGGLADGLEAYADK-----TLQEMKALFPIW-----SQELPFVDVTVAVHVVDRPRYVMRLQASATIRSVAYV-ANPTEDLDCGSSVVIKEPVHVVY--
Covid-19 SGVTRELMRELNGG--AYTRYVDNFCGPDGYPLECIKDLLARAGKASCTLSEQLDFIDT--K-RGVYCCREHEHEIAWYTERSEKS--YELQTPFEIKLAKKF-DTF-NGE-----CPNFVF--
GCCDC1 -----GGN--TF--LTDQYGFADGVLAAPIKEVLGGKAGM--SLVELTKFLGKY-RTADGYELPSGIVKVAKVVVRKKNLP--YSKQSIFTVLGVTE-----RV-----VDGFYYPY
HKU1 QKAYALL-RQYRGI--KPVLFVDQYGC DYSGLKADCLQAYGHY-----SLQDMRQKQSVW-----LANCDFDIVVAHVVRDSRFVRLQTIATICGIKYV-AQPTEDVVDGDDVIREPVHLL--
HKU14 KKAYALL-RGYRGV--KPLLYVDQYGC DYTGNLAEGLEAYAEF-----SLQEMKELFPIW-----SLSLPYDVVVAHVVRDPQFVMKLOSLATIRSI EYV-AEPTEDLV DGT VVIKEPVH TL--
HKU24 AKAYALL-RQYRGL--KPLVFVDQYGC DYTGSLAQGLSAYGEC-----SVKEMRA--GMW-----KTS DQFEYVVAWHTVVRDERFVMSLQTCATIRSIAYV-ADPMDLEGDQVVVKEPVHVL--
HKU4 QNLLKKLI---GGD--CI--PIDQYMC GKNKPIADYAKIVAKEGLTTL--ADIEVDVKS R MDS DRFIVLNKKLYRVVWNVTRRNVP--YPKQTAFTIVSVVQC-DDK-DS-----VPEHTF--
HKU5 QSLKKLIV---GGD--FT--PIDQYMC GKNKPIAEFAALMASEGITKL--ADVEAEVKSRTDSRYIVFKNKLYRIVWVQRKVA--YSKQSAFTMNSIVQL-DTM-ED-----VPRHSF--
HKU9 -----GGD--VY--LSDQYGF DNNGILVEPVMKLLGVIKSDF-TLEQLLAALGKY-RTEDGYDLPDGYVKVAIKVGRKAVP-VLKQSIFTVGVTE-----QL-----VPGYYPF
Hedgehog-CoV NKLYKKLC---GGD--VI--PVDQYMC GFDGSPIKPYLDLANKEGLTKL--ADVEADVCSRVDKQGF LIFKGT TYRVVWFTERKDVD--YSKQTLFTVICVMQR-NGV-HD-----IPAHPF--
MERS-CoV QNLLKKLI---GGD--VT--PVDQYMC GVDGKPI S AYAF LMAKDGITKL--ADVEADVAARADDEGFI TLKNNLYRLVWHVERKDVP--YPKQSIFTINSVVQK-DGV-EN-----TPPHYF--
MHV CKAYALL-KGYRGV--KPILFVDQYGC DYTGLAKGLEDYGD L-----TLSEMKE LFPVW-----RDSL DSEVLVAHVDRDPRA MRLQTLATVRCIDYV-GQPTEDVVDGDDVVVREPAHLL--
OC43 KKAYALI-RGYRGV--KPLLYVDQYGC DYTGSLADGLEAYADK-----TLQEMKALFPTW-----SQEL LFDVIVAVHVVDRPRYVMRLQSAATIRSVAYV-ANPTEDLDCGSSVVIKEPVHVVY--
Rat-CoV RKAYTLL-KGYRGV--KPILFVDQYGC DYTGLAKGLEDYGD L-----TLSEMKE LFPVW-----RESLDNEVVVAHWVDRPRA MRLQTLATLRSIDYV-GQPTEDVVDGDDVVVREPAHLL--
SARS-CoV SGALRELTRELNGG--AVTRYVDNFCGPDGYP LDCIKDFLARAGKSMCTLSEOLDYIES--K-RGVYCCRDHEHEIAWYTERSDKS--YEHOTPFETKSAKF-DTF-KGE-----CPKFVF--
229E -----VFGKRGGG--NVTYTDQYLCGADGKPVMS EDL-----WQFVDHFGE--NE--EIVINGRTYVCAWLTKRKP-LDYKRONNLAET EYVHG DALHTLRNGSVL-----
Bat-CoV-1A -----VFGCGGGT--SIP--VDNYMCGANGKPVLPEDM-----WCFCDYFGD--DGD-NITVNGQAYHKAWNVTRGD-VPYQFQONASTILSIEYL-ADEKHLVDPGAVA-----
BtCoV512 -----VFGRCGGT--TIPVDQFMC GADGAPVIQEGD-----WTFMDYFQD--SN--QFTLNGITYVKAWDVDRKP-NDYAKQNVTCIRIRITYI-TDHRHVLADGTTM-----
BtMr-AlphaCoV -----VLGRRGGA--PPIYVDNYLCGADGTPVQESM-----WSYTDHFGE--DCD-ETLTCGITYVHAWNVQRAD-VPYEQNVTSIFSIEYL-LDVDHALQNGAVL-----
BtNv-AlphaCoV -----VSFDGLA--GAEVYVDNYMCDQTGKPVLAADV-----WTFKDYFGE--SDT--IVIDGVYRKAWEVVRLD-VPYKAQSVSAISSIEWL-CGVHLPNGSTVL-----
BtRf-AlphaCoV -----VFGRRGGN--TVYVDNYMCGSNGVPVLPEDQ-----WEFVDYFGE--LTE--VSGDTTYIKAWNVDRVE-GPYKQTLLSINAI SYC-GEVIVALADGSTM-----
CDPHE15 -----IFGRRGGN--TIYVDQYLCGADGKPVVPEEF-----WDFKDYFVD--DD--QVVVNGTTYIKAWVVERAN-VAYEAQNVTAINGITYC-AKIPHTLPDGSVV-----
FCoV -----KFARTGNG--AIYVDQYMC GADGKPVIEG-----EFKDYFGE--EDV--IIEGEEYHCALWTVRDE-KPLWQO TLLTIREIQYN-LDIPHKLPNCAIR-----
Ferret-CoV -----SLSTYGGM--TVYVDQYMC GADGRPVISG-----EMRDYFGD--LDD--IVIDGIIYSHAWDVERDLVDTHDKQTF LNKSIMYL-QDKDHKLPNGAIR-----
HKU10 -----IFGNRGGT--TVFVDNFLCGANGLPACSEQE-----WEFKDYFGE--LDE--VIINGTTFVKAWNVDRTP-GPYSTQNLLSINSISWC-GEIPHSLADGSIR-----
HKU2 -----IFGKRGGD--VVPVDNYMCGADGKPAVPSEQ-----WSFVEHFDD--DTD-ETVNGVTFRHAWNTVRAD-DPYEKGLLSIKFIEYI-SNVPHKLPNGSVL-----
HKU8 -----IFGFGGGD--ASPVYVDNYMCGANGKPVLPADV-----WVYQDYFGE--ETE--LIVNGVKHVKVWHVTRTD-IPYQFQSLGAI ESIEWL-TDIPHTLRNGSRL-----
LuchengRn-CoV -----FLGRSRGGIAPNPIYVDQYLCGPDGTPVKK--G-----LEFKDYFMN--GGD-IYVEPGKTYRVVWVDRVERKQ-DDLTL D--GILSIKYL-SDKPHKLRDGAIQ-----
Mink-CoV -----RINNIGGT--VVYVDQFLCGADGKPVVRQG-----EMKDYFGD--LED--IVIDDITYKHAWEVARDMDVPHAKQTALNVQSI IYL-MDVDHKIVNGATR-----
NL63 -----VFGH-GAG--SVVFDKYMCGFDGKPVLPKNM-----WEFRDYFNN--NTD-SIVIGGVTYQLAWDVIRKD-LSYEQONVLAIESIHYL-GTTGHTLKS GCKL-----
NL63-related -----IFGD-GAG--DVVVDNYMCGFDGKPVLPETI-----WEFKDYFGD--DVD-NITINGVSYQLAWDVTRKP-LSYKQONVLAIESIRYL-GSKEHTLRAGCKL-----
Porcine-EDV -----TFGRRGGN--IVPVDQYMC GADGKPV LQESE-----WEYTDFFAD--SE DQ LNIAGITYVKAWIVERSD-VSYAQNLT SIKSITYC-STYEHFLDGTAM-----
TGE -----KIARTGRG--AIYVDQYMC GADGKPVIEG-----DFKDYFGE--EDI--IEFEGEEYHCALWTVRDE-KPLNOOTLFTIOEIQYN-LDIPHKLPNCAIR-----



390 400 410 420 430 440 450 460 470 480 490 500

Bat-BCoV APDCAVQVMMKPRKVKRGADGFMTKLRR---VYNING-----F--DEVKPMALCALHYC--EDCGMEMWCHSN-FEEAYCPC-GKIYNTTPC--TLTSAAGYVVEGSSVAMPDCACKSDSDHS--NGT

Bovine-CoV ADDSIIILRQ-HNLVDIMSCFYMEADAVVNAFYGV-D-----L--KDCGFVMQFGYIDCEQDLCDFKGVWVPGNMIDGFACCTTCGHVYETGDL--LAQSSGVLVFNVPVLTHTKSAAGYGGFGCK-----

Covid-19 PLNSIIKTIQPRVEKKKLDGFMGRIRS---VYPVAS-----P--NECNQMCLSTLMKC--DHCGETSWQTGD-FVKATCFE-CGTENLTKE--GATCCGYLPQNAVVKIYCPACHNSEVGP--EHS

GCCDC1 STNSVVSYTKPRAGATVGNVTVLRLS---MYGT-----EAYNPVTPVVALRC--SSCDFYGVWVVKDLGCVTCSG-AAVHQITSSCIDAESAGLIKQGAVMLV-----

HKU1 SADAIVLKL-PSLMKVMTHM---DDFSIKSIYNV-D-----L--CDCGFVMQYGYVDCFDNDCDFYGVWVSGNMMDGFSCPLCCTVYDSSEV--KAQSSGVIPENPVLFTNSTDT----VNH-----

HKU14 APDAIVLKL-PKLIDLMOHT---DSTVVESIYKT-K-----L--KHCGFVMQFGYVECSQDDCTFTGWVPGNMIDGFACCTSCAFVYGTVDL--LAQSSGVMPQNPVLTHTKQAI----TNG-----

HKU24 SADATVKKF-VKIADLMQVT--DAVSVIETVYKV-P-----I--KDCGFVMQFGHVQCEHDECEFEVWIPGNMIDGFKCPA-GKLYAASEV--QAQSSGVIPNAVLFTESTAL----TSQ-----

HKU4 TIGSQILMVSPLKA-TNNKNFNLRQLLYTFYQKDA-----V--QQPGYIYHSAYVDC--NACGRGTWCTGNAIQGFACDC-GANYSANDV--DLQSSGLVPRNALFLANPCANNG----ACSHS

HKU5 TIGSEIQVIAPSTAVQANGHLNLKQRLLYAFYQKA-----V--SEPNIYHSAYVDC--TSCGKGSWLTGNVQGFACDC-GAHYCANV--DLQSSGLVLRKNAVLLTTCPCNKDG----ECKHT

HKU9 STSSVVEHTKPTRGGPVGKTVEAVMLS---LYGT-----NNYNPATPVARLKC--SYCDYYGWTPLKDIGTVNCLC-GAEFQLTSSCVDAESAGVIKPGCVMLL-----

Hedgehog-CoV TLGSKVEQLKPHVAKGNLVGLTLKAKILYTMYGEDA-----V--EEPSYIYHSAFVDC--VKCNEGKWTGNVAVGFACEC-GAAYTAKQV--LLQSSGLVKSNALFCATCPFAQGDRCSLDCKHT

MERS-CoV TLGCKILTLTPRNKWSGVSDLSLKQLLYTFYQKES-----L--ENPTYIYHSAFIEC--GSCGNSWLTGNAIQGFACGC-GASYTANDV--EVQSSGMIKPNALLCATCPFAKGDSCSSNCKHS

MHV AANAIVKRL-PRLVETMLYT---DSSVTEFCYKT-K-----L--CECGFITQFGYVDCCGDTCDFRGWVAGNMMDGFPCPGCTKNYMPWEL--EAQSSGVIPPEGVLTQSTDT----VNR-----

OC43 ADDSIIILRQ-YNLVDIMSHFYMEADTVVNAFYGV-A-----L--KDCGFVMQFGYIDCEQDSCDFKGVWVPGNMIDGFACCTTCGHVYEVGDL--MAQSSGVLVFNVPVLTHTKSAAGYGGFGCK-----

Rat-CoV AADALVKRL-PRLVETMLYT---DSSVTEFCYKT-K-----L--CDCGFITQFGYVDCCGDTCDFRGWVPGNMIDGFPCCGCSKSYMPWEL--EAQSSGVIPPEGVLTQSTDT----VNR-----

SARS-CoV PLNSKVKVIOPRVEKKKTEGFMGRIRS---VYPVAS-----P--OECNMHLSTLMKC--NHCDEVSWOTCD-FLKATCEH-CGTENLVIE--GPTTCGYLPTNAVVKMPCACODPEIGP--EHS

229E -----EMAKEVK-TSSKVVLSDALDKLYKVFVMTNGSNILEAFTKPVFISALVQC---TCGTKSWSVGDWT-GFKSSCCNLISN--KL---CVVPGNVKPGDAVITTOQAG-----

Bat-CoV-1A -----KSAKPPK-FSKNIVLSEKYKALYDACGNPFVTNGTNVLEVVNTNPIFAHGFVQC---KCGSKHWTGDAW-GFKSVCCGIPGR--VL---CTVFGVAPGSVLLTSTRVDASP-----

BtCoV512 -----KTARHPK-VNKSIVLDSPPDIYKEVGSPEFMNGSTFVEMLKDPAFFHALITC---ECGRSEWTVGDWK-GYNSLCCNIKCK--PI---TIVTPKAVPGAVVITKAGIG-----

BtMr-AlphaCoV -----NVASGVK-YKKSIVLSEGFKKLYDACGPAVQNGNTLVDILTTPAFFHAIIVSC---SCGLSSYTVGDWIKGFRSLCCGKRLE--PI---TVVVDVVKPGDIVVTSANAG-----

BtNv-AlphaCoV -----DVAKSVS-KSKVLLSDPYADIYDQVGSPEFMNGKLNLEIVVKPCFLHGYVCK---NCGNTHWAVGDWRAGYKSVCCGLNCN--PI---CVAAGYVEPGDVLFTSKGAG-----

BtRf-AlphaCoV -----SYATAVK-KNSKTVVNKTQKLYDNIGVPFVTNGKVLTEIIPKPVFNHGLVCK---HCGKVSWTVDGWS-CYKSTCCGIVCK--PI---AIVNGDVNPGDVVITTSKQVA--T-----

CDPHE15 -----RVARKPK-IKKSIVLSDVYKPLLEGLGAPFVKNGDTLASILTEPVFLHALVCK---TCGKTMWTVGDWS-CYKSLCCGVVCK--PL---CNVAGIVNPGSAVVTRTGLG-----

FCoV -----EVAPPVK-KNSKVVLSEYRKLVDIFGSPFMNGDSLNTCFDSLHFAATLKC---PCGAESGSGVDWT-GFKTACCGLHGK--VK---GVTLGAVKPGDAIVTSMAG-----

Ferret-CoV -----VRAAPVK-LSSKVVLSPFADMYKHFQSPYMQNGDNLHGCFTKLNFIVANVCK---KCGGESGSGVDWT-GFKSACCGLPK--VI---GVSIGNAAVGEAVVTSKGG-----

HKU10 -----RVAKVVK-KSKSVLLGKQFQQLYDSVGSPEFMNGKNTDVLVKPIYCHALVCK---QCGKTSWTVGDWS-CYKSMCCGFNCK--PL---AIVNGEVPVGDVLTSDKVS--A-----

HKU2 -----GVAGTPK-KRKAVVLDEKYSKLYDACGVPFVTNGKSISEVTKPLFLHALVEC---KCGNESWTVGDWT-GFKTCCGVTGK--VI---TLAVGDVTPGDIVFTTPGAG-----

HKU8 -----SAARAVK-HSKNVVLSEPLTLYQACGSPFVTNGSTLREAVPKPVFAHAYVAC---KCGRKAWSVDGWS-GYKSTCCGVFGK--PQ---CVVFGVVPVGDVFTTSSVG-----

LuchengRn-CoV -----GVADAVS-E-----LNDTNQMVRFIHFVSC---PCGKSAFTVGSWM-GFATVCCGKIVKT--PM---CVKFSGEAGSIFALPVGSRGSA-----

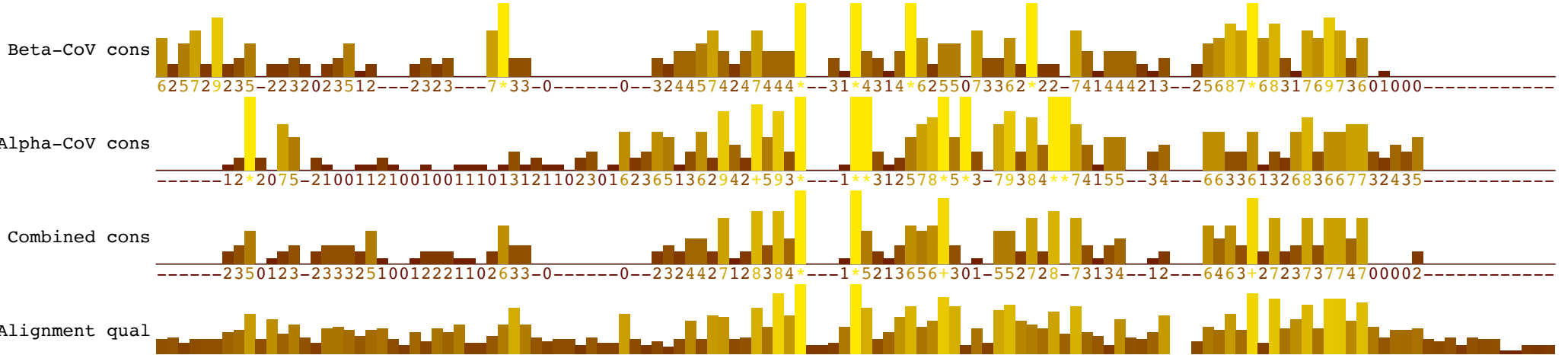
Mink-CoV -----QRAAPVK-ISSKVCLTEPYNLSYKQFGSPYMQNGNLNECFSKLNFIVANVCK---KCGGESGSGVDWT-GFKSACCGTPK--VI---GVSIGDASVGEAVITSKGG-----

NL63 -----TNAKPPK-YSSKVVLSEGNNAVYRAFQSPFITNGMSLLDIIVKPVFFNAFVCK---NCGSESWSVGAWD-GYLSGCCGTPAK--KL---CVVPGNVVPGDVITTSAG-----

NL63-related -----FNAKQPK-YSAKVVLSEWIEVYKAFGSPFVTNGSSLLEILTTPVFFNAFVEC---NCGNKGWSVGAWD-GYLSGCCGTPAK--KI---CVVPGNVVPGDVLVTSNAG-----

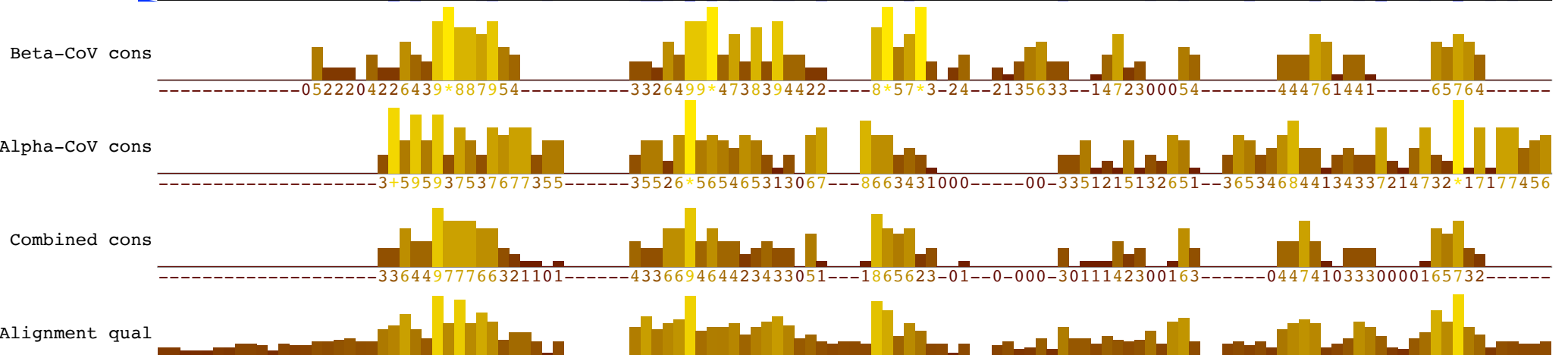
Porcine-EDV -----KVARTPK-IKKNVVLSEPLTIYREIGSPFVDNGSDARSIRRPVFLHAFVCK---KCGSYHWTVDGWT-SVSTCCGFKCK--PV---LVASCAMPGSVVVTRAGAG-----

TGE -----HVAPPVK-KNSKIVLSEYKLYDIFGSPFMNGDCLSKCFDTLHFAATLRC---PCGESGSGVDWT-GFKTACCGLSGK--VK---GVTLGDIVKPGDAVVTSMAG-----

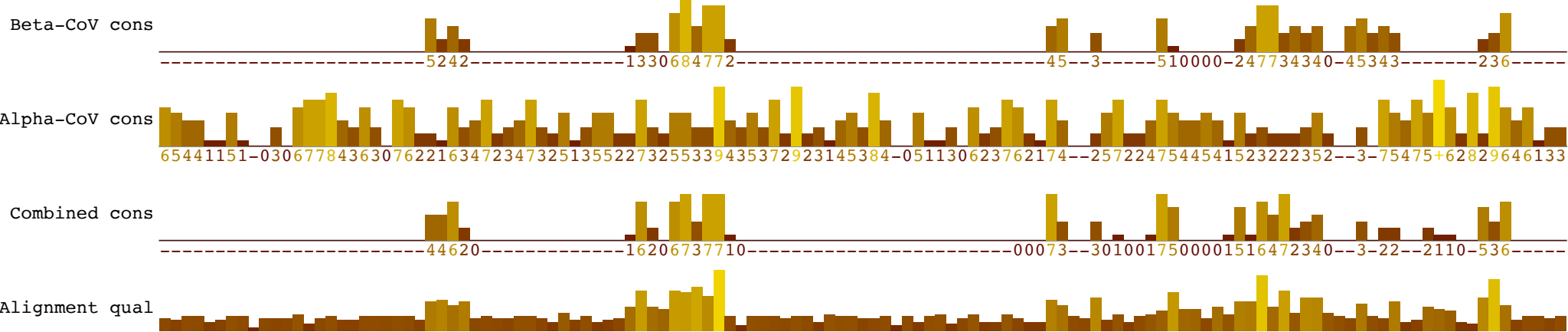


510 520 530 540 550 560 570 580 590 600 610 620 630

Bat-BCoV FYDSCKYLAEDK--AEPGNRENFVYFGGCCFAYVGC-----NGNAIWPVRAHSDIGNNH----SGIVGA-DV--A-LLNDDLKAIVAQEVIPV-----VIPEDFKVNETVVALVAAVS-----
Bovine-CoV -----DSFTLYGQTVVYFGGCVYWS-----PARNIWIPIILKSSVKSVDGLVYTGVVGC-KA--IVKETNLICKALYLDYVQH-----KCGNLHQRE----LLGVS-----
Covid-19 LA---EYHNESGLKTIILRKGRTIAFGGCVFSYVGC-----NKAYWVPRASANIGCNH----TGVVGE-GS--E-GLNDLLEILQKEKVN-----NIVGDFKLNEEIAIILASFS-----
GCCDC1 -----DRSPSMRVVPG-NRLYVAFGGAIWSPIGKV-----NGVQVWVPRAYS CVAGDH----SGAVGS-GD--VNTINKEIMSLIID--GV-----RIDDEVLEQPSCGVLIANLE-----
HKU1 -----DSFNLYGYSVTPFGSCIYWS-----PRPGLWIPPIIKSSVKSYYDDLVSYGVVGC-KS--IVKETALITHALYLDYVQC-----KCGNLEQNH-----ILGVN-----
HKU14 -----DSFKLYGNSVIPFGGCLYWS-----PTPGVWLPLIKSSVKAYDGMVYTGVVGC-KT--IVKETEAVCKALYLDYVQY-----KCSDLKQRE----GLGLA-----
HKU24 -----DSFKMYGMSVVPFGGCVYWS-----PGSGIWLPIIMSAYKAYDGMTFTGSIGF-KT--IVQETAACHALYLDYVQY-----KCADIKQHA-----ILGVD-----
HKU4 AAQVYNILDG-KACVEVGGKSFLLTFGGVVYAYMGCC-----DGTMYFVPRAKSCVSRIGDAIFTGCTGT-WD--KVETAN--LFLKAQRSL-----NFCQQFALTEVVLAILSGTT-----
HKU5 LPQLVSMMTD-KCDVEVVGKTFILTYGGVIYAYMGCS-----GGTMHFIPRAKSCVSKIGDAIFTGCTGT-WD--KVCETAN--LFLERAQHAI-----NRFVNEFVLTETVVALLSGTT-----
HKU9 -----DKSPGMRLIPG-NRTYVSFGGAIWSPIGKV-----NGVTVWVPRAYSIVAGEH----SGAVGS-GD--TVAINKELVEYLIE--GI-----RVDADTLDNPTCATFIANLD-----
Hedgehog-CoV VPQVVSYLSE-KCVVPSGKSFVLAFGGALYTYMGCA-----EGTMYFVPRAKSVSRIGTACTGCVGA-WD--KVQVAN--LFTQKAQQQL-----NRFVNEFVSDVVLAILTGT-----
MERS-CoV VAQLVSYLSE-RCNVIADSKSFLLTFGGVAYAYFGCE-----EGTMYFVPRAKSVSRIGDSIFTGCTGS-WN--KVTQIAN--MFLQEQHSL-----NRFVGEFVNDVVLAILSGTT-----
MHV -----ESFKLYGHAVVPPFGSAVYWS-----PCPGMWLPVIWSSVKSYSGLTYTGVVGC-KA--IVQETDAICRSLYMDYVQH-----KCGNLEQRA----ILGLD-----
OC43 -----DSFTLYGQTVVYFGGCVYWS-----PARNIWIPIILKSSVKSYSLSLVYTGVLGC-KA--IVKETNLICKALYLDYVQH-----KCGNLHQRE----LLGVS-----
Rat-CoV -----EAFKLYGHAVVPPFGSAVYWS-----PYPGMWLPVWSSVKSYSGLTYTGVVGC-KA--IVQETDAICRSLYMDYVQH-----KCGNLQRA----TLGLD-----
SARS-CoV VA---DYHNHSNIETRLRKGGRTRCFGGCVFAYVGCY-----NKRAYWVPRASADIGSGH----TGITGD-NV--E-TLNEDLLEILSRERVNI-----NIVGDFHLNEEVAILASFS-----
229E -----AGVKYFCGMLTKFVANI-----EGVSVWRVIALQSVDCFV---ASSTFVEEEH--V-NRM-DTFCFNVRNSVTD--ECRLAMLGAEMTSNRRQVASGVVIDISTGW
Bat-CoV-1A -----GATRYYHGLTLKHICNV-----DGVACWRVTKVQGVFCFV---ASGSIED--C--V-GSTFDCTYDNYTSFAK--AFKCGMLTGSFSDNVVASVINGTLDVGLAV
BtCoV512 -----AGLKCYNNVFLKHIIDLVPVPTNLGWGVWRIAKVQSKDDVA---TSGNVLVDDP--E-DRL-DPCYFGNDGPFAT--KFKFQLLANSFPDEVKGAIVQGVVHVNTAI
BtMr-AlphaCoV -----DGRYRNFGLTLQYVGDW-----EGVSCWRAVGVQAFNGFV---ASPTFDEQLH----TYSLDACAYTSNTRLFK--ALKLSVLSGFTNDDVTNAVIAGVVDVNSCV
BtNv-AlphaCoV -----TGLKYYKGLTLKFFVGEV-----ENVAVWRIQKVHHDVDFV---ACNRFKDDFC----STMESCGVENVSATAN--ALKFSLISGCCQEVTLRSIVSGQLSVGFV
BtRf-AlphaCoV -----NGVKYYNGMVLKYVDTI-----EDVHLWRVVKLQSVKGFV---ASPNYDPAEY--V-FLADDACSPTSRLVISA--SYKLGLLNGNFDDVRAARDGTIVVGNV
CDPHE15 -----SGIKYYCGMFLRHILDV-----DGVSVWRVIRLQSAGETV---TSTNFEFEGD--V-CPM-DTCHYSLDSRLAV--MFKLNLLSGDFCAEVRHAIASGVFSVGNFI
FCoV -----KGVKFFANSVLQYAGDV-----ENSVVWVKIKTFTVNETV---CTDFEGELN-----DFIRPESTSPVSC--SIKRAFITGEVDDAVHDCI IAGKLDLSTNL
Ferret-CoV -----NGTKFYANAVLKHVGDV-----DDVSIWRVMATYAKD-IV--ATNTFDKCR-----ELLDHTSDSTLAT--SVKCYLTGKPNKDVVDAIVAGHINVSSNI
HKU10 -----SGTKYYNGMVLKFDVKI-----DNACLWRITQVQSCMDV---ASGNYKGEF--I-YHTDDICSPNTMSKISH--AFKLCYFTGYSYTDVKSALLHGEFDVCTNI
HKU2 -----KGTKFFCGLVLTFFVDTL-----EGVSAWRVVKAYTVDFV---ASSNFDEHNN--V-MSL-DQCSFDNFSPISV--ALKFSLLRGNCCDDVKVAVATGVVIDIGLV
HKU8 -----SGTRYNGLTVKHVVTV-----DGLACWRVLTQSVGLT---ATPSFDD--Y--S-DAAFDCCVYHNTQLAV--AYKMGLLSGNFDETVIDGVLGAVDVGSAV
LuchengRn-CoV -----NGKRSYAGAEFQFCCEL-----SGVEIWCCTKTFSVDGVC---TVGAHLITASDPIYATLFPNTCMLGDDGLSTDYDLCYSIIAKCANDGLSQRIIRGALNAsAQL
Mink-CoV -----TGTKFYAGAVLKYVGDV-----EGVSVWRVMTYAND-VV--ATTFDKCKL-----ALLDHDNSNLVAN--SVKCYLTGEPDATVVDIVAGHVNLSNI
NL63 -----CGVKYYAGLVVKKHITNI-----TGVSLWRVTAVHSDGMFV---ASSYDALLH--R-NSL-DPFCFDVNTLLSN--QLRLAFLGASVTEDEVKFAASTGVVIDISAGM
NL63-related -----TGTKYYAGLVVKKHVNV-----SGVSLWRVTAVQSDGAFV---ATSSYDEVLLH--K-NSL-DPFCYDVSTRLSL--QLRLAFLGAPVTEDEVKVAATSGVIDISAGM
Porcine-EDV -----TGVKYYNMFRLRHVADI-----DGLAFWRILKVVQSKDDLA---CSGFLEHHE--E-GFT-DPCYFLNDSLAT--KLKFDLISGKFSDEVKQAI IAGHVVSAGL
TGE -----KGVKFFANCVLOYAGDV-----EGVSIWVKIKTFTVDETV---CTPGFEGELN-----DFIKPESKSLVAC--SVKRAFITGDIIDAVHDCIITGKLDLSTNL



| | 640 | 650 | 660 | 670 | 680 | 690 | 700 | 710 | 720 | 730 | 740 | 750 | 760 |
|----------------------|------------|-----------------|------------|-----------|-------------------------|---------|-----------|---------------|------------------|-------------------|-------------------|---------------|--------------------------|
| <i>Bat-BCoV</i> | ----- | ----- | GSVD----- | ----- | QFIKNCGLTA----- | ----- | ----- | ETFKCLLEASG-- | KFRVTV | DHVIDGCI | CVATDSAVTAL | EPA-- | LAFCTAAN---- |
| <i>Bovine-CoV</i> | ----- | ----- | DVWHK----- | ----- | QLLLNRGVYKPLLENIDY----- | ----- | ----- | ----- | FNMR----- | ----- | AKFSLEFTFTVCADGFM | PFLLDD----- | LVP----- |
| <i>Covid-19</i> | ----- | ----- | ASTS----- | ----- | AFVETVKGLDY----- | ----- | ----- | ----- | KAFKQIVESCG-- | NFKVTKGKAKKAWNIGE | QKS-- | ILSPL-- | YAFASEAA---- |
| <i>GCCDC1</i> | ----- | ----- | DPSAA----- | ----- | PRVHTVDSL----- | ----- | ----- | ----- | RQLCV-- | DNNVMLGD---- | TPLPKDEFH-- | PGIVG-- | LSYHFYRA---- |
| <i>HKU1</i> | ----- | ----- | NSWCR----- | ----- | QLLLNRGDYNMLLKNIDL----- | ----- | ----- | ----- | FVKRR----- | ----- | ADFACK-- | FAVCGDGFV | PFLLDG----- |
| <i>HKU14</i> | ----- | ----- | DVWHK----- | ----- | QLLINRGDYQPLLDNVDY----- | ----- | ----- | ----- | FSMRR----- | ----- | ARFSMETATVCSEGF | MPFLLDG----- | LVP----- |
| <i>HKU24</i> | ----- | ----- | DLWHK----- | ----- | QLLFNRGDYSLLLENVDY----- | ----- | ----- | ----- | FIMRR----- | ----- | AKFSVDNSLVCSEGF | FAPFLLDG----- | VAA----- |
| <i>HKU4</i> | ----- | ----- | STFE----- | ----- | ELRDLCHNAS----- | ----- | ----- | ----- | YEKVRDHLVNHGFVVT | IGDYIRD | AINIGANGVCN | ATINAPFIAFT-- | GLG----- |
| <i>HKU5</i> | ----- | ----- | SSIE----- | ----- | ELRDLCRNAT----- | ----- | ----- | ----- | FEKVRDYLT | PRGWI | VTMGSYIEGV | INVGAGVCNAAL | NAPFIVLS-- |
| <i>HKU9</i> | ----- | ----- | CDTKA----- | ----- | PVVHTVESL----- | ----- | ----- | ----- | QGLCL-- | ANKIMLGD---- | KPLPTDEFH-- | PFIVG-- | LAYHVQRA---- |
| <i>Hedgehog-CoV</i> | ----- | ----- | STLD----- | ----- | ELRSLLQGIT----- | ----- | ----- | ----- | FEKMRDYCVKHG | IKV | TMGDYVDSAIN | VGGASVRSAAIN | APFVVLS-- |
| <i>MERS-CoV</i> | ----- | ----- | TNVD----- | ----- | KIRQLKGV----- | ----- | ----- | ----- | LDKLRDYLD | ADYDVA | TAGPFMDNAIN | VGGTGLQYAAI | TAPYVVL-- |
| <i>MHV</i> | ----- | ----- | DVYHR----- | ----- | QLLVNRGDYSLLLENVDL----- | ----- | ----- | ----- | FVKRR----- | ----- | AEFACK-- | FATCGDGLV | PLLDG----- |
| <i>OC43</i> | ----- | ----- | DVWHK----- | ----- | QLLLNRGVYKPLLENIDY----- | ----- | ----- | ----- | FNMR----- | ----- | AKFSLEFTFTVCADGFM | PFLLDD----- | LVP----- |
| <i>Rat-CoV</i> | ----- | ----- | DVYHR----- | ----- | QLLVNRGDYSLLLENVDL----- | ----- | ----- | ----- | FVKRR----- | ----- | AEFACK-- | FATCGDGFV | PLLDG----- |
| <i>SARS-CoV 229E</i> | ----- | ----- | ASTS----- | ----- | AFIDTIKSLDY----- | ----- | ----- | ----- | KSFKTIVESCG-- | NYKVTGKPKV | GAWNIGOOS-- | VLTP-- | CGFPSSOAA---- |
| <i>Bat-CoV-1A</i> | LDVTTAV--- | TKPWFVLKCGSLLES | AWDALIMA | IQLPVMAS | DVLKFFNNLT | QVLIVVR | NGVIDII | HSVPEAFKSAFE | EIFK-- | DLVTG | VFDLVVDHFK | IANKKFK-- | R-AGDYILFENALACLVSG |
| <i>BtCoV512</i> | CDVVKDIL-- | GLPWFVKLGLSLVT | MWDQFVAG | VQSMKICTL | KVVQLAKAL | SCATMSV | VKGVITLV | AEVPEIFKRL | FYTLT-- | SALKSLCT | SSCDALV | VAGKSF-- | K-IGDYVLLPSALVRLVSS |
| <i>BtMr-AlphaCoV</i> | YNFVDAVL- | EQKPWFVRKLGKLC | ETAWSLL | CDALKES | SSLSSDL | VAFVKS | LTAVLTV | VDGKLLI- | ADIPSVFES | VDFVK-- | SALEGIF | DACANTVT | IAGKAVR-- |
| <i>BtNv-AlphaCoV</i> | FDTFEDIF- | SM-PKWMQRLGAL | GSTLWSQ | FKSFARE | FTKSTSL | VEFVN | FLRDVSC | VVMNGALEL | V-ANVPNH | FASLFDHLR- | VLVASV | TTLFIEEFK | VAGVAFK-- |
| <i>BtRf-AlphaCoV</i> | LSLIDVV-- | LTKPWFVRKLEELL | GEAWDTF | VASLKNL | VFTSTQ | LVELTK | ALS | KAVLNVT | KEGIEFA- | AEVPSCF | FESCF | SVFK-- | EFVTGIFDFTVNSVKIAGRSFK-- |
| <i>CDPHE15</i> | CDVTDVVL-- | GKPWFVKLGLV | LADA | AAWTF | VASLRK | IKVMSS | QLVDLAKAL | CASVSV | INRCLVLA- | ADVPP | IFKECF | AKFV-- | SAIAALFKSTCDTVKVARHSYP-- |
| <i>FCoV</i> | FGSANLLF- | KKMPWFVQKCGA | IFADAW | KVVEEL | CSLKLTY | KQIYD | VASLCT | SAFTIM | DYKPVF | VVSS-- | NSVKDL | VDKCV-- | KILVKAFD |
| <i>Ferret-CoV</i> | FGVVKELF- | ANVPWLLRSV | VNCFLO | HGSLF | VRFVFL | SSGGHSY | VVVRD | TIKMLCS | AAFTIQ | GLKPV | FVISS-- | A-ASSLVK | SCI-- |
| <i>HKU10</i> | CDVSDHS-- | IHKPWFVREME | ELLGGAW | NDFV | KAVKSL | SVLNS | QLFDLMS | GAKATIR | VVNG | CIEFC- | ANIP | TCFNDA | FELCK-- |
| <i>HKU2</i> | FDVNDTVF- | ENVPWFVQKFE- | FLKPA | WDALK | QAIINL | GVTSK | AVLSF | IKSLCS | AAFSV | DGV | PVIV-- | CTVAER | FSKAF |
| <i>HKU8</i> | LDVIDRIC- | DAQPWF | IQKFG | ALFESA | AAAFV | ATLKK | IPALS | SEFV | QLCSAL | QKAIL | TVR | DGVID | DFYVEN |
| <i>LuchengRn-CoV</i> | FSNTVDL | FMSAKL | WFMEH | CTPMF | SSAMKYL | WDAIK | KLACTT | KKEL | KRF | WDHLC | NAKLY | VENHIL | RFS-- |
| <i>Mink-CoV</i> | FGAIPVLF- | EKT | PWFV | KKCGAL | FETA | WQSICK | FLSAG | FTYVAIR | DAINA | ICSIC | FTIK | DSKPL | FIVSS-- |
| <i>NL63</i> | FGLYDDIL | TNNKPWF | VRKAS | GLFDA | IWDAF | VAAIK | LVPTTT | TGVL | VRFV | KSI | ASTV | LVTVS | NGVI |
| <i>NL63-related</i> | FGLYDDIL | TNNKPWF | VRKAS | GLFDA | VWFAF | VAAIK | LIP | TTTQ | CLVK | LKAV | ASAVL | TVSKG | TIVMF- |
| <i>Porcine-EDV</i> | VDIVDDAL- | GQ | PW | IRK | LDLAS | APW | QLKAV | VRLG | LLS | DEV | LV | FGK | R |
| <i>TGE</i> | FGNVGLLF- | KKT | PWF | VOK | CGAL | FVDA | WVVEEL | CGSL | T | TYK | OI | YEV | VAS |



770 780 790 800 810 820 830 840 850 860 870 880

Bat-BCoV -----IMYRTLVAATSVVISAHTLDALAQVRDACKVHHPQAMRL-----L-----NTLN

Bovine-CoV -----RAYYLAV--SGQAFCDYADKICHAVVSKSK-----

Covid-19 -----RVVRSIFSRTLETAQNSVRVLQKAAITILDGISQYSLRL-----I-----DAMM

GCCDC1 -----CWYGVLTAKSFGAFKELLQSEEVRLSHFCANI-----RRC-----L-----DRAL

HKU1 -----RSYYLIQ--SGIFFTSLMSQFSQEVSDMCL-----

HKU14 -----RTYYLVK--SGQAFCDMLCEFGQEVADLSK-----

HKU24 -----RAYYINCLLAPGLPESLCKLGLIEVGSWCQ-----

HKU4 -----ESFKKVAIPWKICSNLKSALDYSSNIMFRVFPYDIPC-----D-----VSNFV

HKU5 -----ESFKKVAATPWKLCSSLRETLHDHYADSIYRVFPYDIPC-----D-----VTDYT

HKU9 -----CWYGALASRTFEAFRDFVRTEEERFAQFFGKV-----CAP-----I-----NGCV

Hedgehog-CoV -----ESFKKIAAVPFKVGSSFLKTWEYLSDCIVYRVLPELE-----D-----VSDFV

MERS-CoV -----ESFKKVATIPYKVCNSVKDTLAYYAHSVLYRVFPYDMS-----G-----VSSFS

MHV -----RSYYLIK--SGQAFSTMMVNF SHEVTD MCM-----

OC43 -----RAYYLAV--SGQAFCDYADKICHAVVSKSK-----

Rat-CoV -----RSYYLIK--SGQAYTSMMPVNF SHEVID MCM-----

SARS-CoV -----GVRSIFARTLDAANHSIPDLORAAVTILDGISEOSLRL-----V-----DAMV

229E KLKGVREGGLNKVKYATVVVGSTEEVKSSRVERSN-AVLTIANNSKLSDEGYTVVIGDVAYFASDGYFRMAS-PNSVLTAVYKPL----VDFNVNVI-GTRP--EKFPPTVTC--ENL-ES-AV

Bat-CoV-1A KIKGVKQAGLKKLLYAKAIVGATVKVTVNRIESAT-VKLVECK-PSNFVKKGSAVVINNI AFFHSDGVYRLMSD-SDEVYEDIAFTAES-VSTVKKPVFD-CTKP--VDFPDISST--DVE--VLV

BtCoV512 KVKGKAQSGIKQLQFATVVLGDTHKVESDRVEFSS-VNLKMVDEEFPLNPVGHVAVGNQAFFCSDGLYRFMAD-RDLVITSPIFKPE----LELEPIFE-CDAI--PGFPKVAAS----N-VAELC

BtMr-AlphaCoV KVSGLKQAGVKNALYASVVIGPTQNVKTRVEVNV-VKLTPIITDKVPFNREGYVALVDGVAFFVNDGYRRLMAD-SDCVLEEPVFKAAS-G-----

BtNv-AlphaCoV KLKGFQDGLKTATYVSTVYGPSKRKVKRVEKCD-ANLVLCD-SAPLVDEGYACVIQQAFTYNTGTYWFMMD-HTSVLESPPVFKD-----

BtRf-AlphaCoV KVKGLHQAGIKQTEYATSIIGKTTKVNKRTEAD-VNLVLVNDKQPLLKDGVTKIIGGKSFYSGGVYRLMSD-NNFVLDPEPVFQEK-----MSVQFE-CEKP--KGFVEPNCD--NLP--SAI

CDPHE15 RITGKKQAGLTEATFADVILGATTNVTSRTEACN-VGLVLCDYDVPVLTNGYTAIIGGKAFFCSEGYRFRMAT-PNVVLDPEPVFRAA----AELNPVFE-CEKP--DGFVPLVAS----D-VAELC

FCoV KILGKRQKGLDSAFFATNLI GATVNVTPQRTESAY-ISLNKVD-DVVT PGGGHIVIIGDMAFYKSEYYFMMAS-PDSVLVNNVFKAAAR-VPS-YNIVYDVNDT KSKMVVKIGTSFDFDGLDAAI

Ferret-CoV KLSGKRESGLKDAVFASAI VGSTIEVKPSRF EKST-ANLVVVE-DVMPGEGHAVVVGDMAFYRSGDYFMMTS-PTSVLTTTTFVKAER-ANV-YKVDYVNP DAYKGLVSAIGTSYSVDGSIDDAV

HKU10 KVKGLHQDGIKSTMYATTVVGKTAKVKSRIETCN-ANLSVVP-DQALVKDGVTKIIGGRSFFCSGGCYRLMSD-VDTVIMSPVYQAV----APTEVFN-CVKP--AGFVDPVCS--TLP--ELV

HKU2 KIKGVKEAGLKTMTYTQCLLGP TKPVKVRVERS-VQLVACA-STPLVENGCTVI VDGIAFFKSGGVYRLMAD-TDLVYETPVY CQQ----ATCKPVFK-CAKP--DGFDPVTSV--NPD--TLA

HKU8 KVKGVQAGAKKVT FATPVIGVAKRVTSTRTEIDS-VQLVACA-STPLVENGCTVI VDGIAFFKSGGVYRLMAD-TDLVYETPVY CQQ----ATCKPVFK-CAKP--DGFDPVTSV--NPD--TLA

LuchengRn-CoV VINGAKEAGLTTAKYFTSVTGKLRVTVRRTEAGDVTLEEVDKVDPPPSGICRLINDYAFYGGGYFPLTA-SDQIEGAVFKAAG-SPLATDDEQPFVEKP--PN--VKLEFEFDN-D-LVM

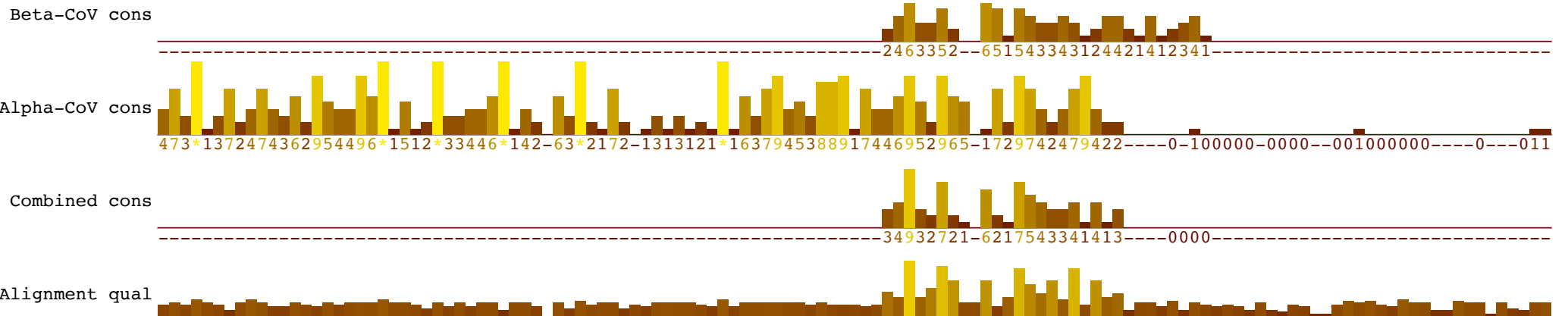
Mink-CoV KLKGREAGLNTATFASAIIGGTAEVNPTRFENST-ANLTLVN-DVVQPGPGYAVVIGGMAFYCTGDYFMMSS-PTSVITTSVFKAST-FNA-FCLRYDVEDPYKTKLVARFGNVYSANGCIDDAV

NL63 VVRGVRDARIKKAMFTKVVVGPTTEVKFSVIELAT-VNLRVLDCAVPVCPKGI VVIAGQAFFYSGGFYRFMVD-PTTVLNDPVFTGD----LFYTIKFS-GFKL--DGFNHQFVT--ASS-ATDAI

NL63-related LVRGVRDVRVKRATFANVVVGATTDVQPSVIEPAM-VNLRVLDYAGSVDPKGRIAVIAGQAFFHSGGVYRFMVS-PTAVLNPAFAGD----ASYNIKFS-GFKL--DGFKHRVVN--AAS-DVEAI

Porcine-EDV KARGPRQAGICEVRYTSLVVGSTTKVSKRVENAN-VNLVVVDEDVLTNTTGRVTVVDGLAFFESDGYRHLAD-ADVIEHPVYKSA----CELKPVFE-CDPI--PDFPLPVA A----S-VAELC

TGE KILGKKOKGLECAFFATSLVGATVNVTPKRTETAT-ISLNKVD-DVVAPGEGYIVIVGDMAFYKSGEYFMMSS-PNFVLTNNVFKAVK-VPS-YDIVYDVNDT KSKMIAKLGSSFEYDGDIDAAI



| | 900 | 910 | 920 | 930 | 940 | 950 | 960 | 970 | 980 | 990 | 1000 | 1010 |
|----------------------|---|-----|------------------------|-----|-----|-----|--|-----|-----|-----|------|------|
| <i>Bat-CoV</i> | EYV-DYST-NSTLVLCHDVI-N-LPI | | | | | | V--LGDILD-RLFCGCKKIVESVTTWLYNFSISTID | | | | | |
| <i>Bovine-CoV</i> | ELL-DVSLDSLAAIH | | LNS | | | | K--IVDLAQ-HFSDFGTSFVSKIVHFFKFTTSTAL | | | | | |
| <i>Covid-19</i> | FTS-DLAT-NNLVMAIITG-G-VVQ | | | | | | L--TSQWLT-NIFGTVYEKLPVLDWLEEKFKEGVE | | | | | |
| <i>GCCDC1</i> | NWA-RTTG-NVSLSSSLVLKA-LAE | | | | | | N--LLDSVK-NTPFLVGLVVKPVLDWIVEKMLVARD | | | | | |
| <i>HKU1</i> | KMC-ILFMDRVSVATFY | | IEH | | | | Y--VNRLVT-QFKLLGTTLVNKMVNWFNTMLDASAP | | | | | |
| <i>HKU14</i> | ELL-VVTLDVSVTSALQF | | LTL | | | | N--VGRLTE-CLKGFGIKFVNKLIQYFKTATRCTAL | | | | | |
| <i>HKU24</i> | STL-CLCIGTVQGATSF | | VVK | | | | N--LKVFLS-KFQIFGKKFVKNVKKLVEEWIKKSVC | | | | | |
| <i>HKU4</i> | ELL-LDCG-KLTVATSYFVRLRY-LDE | | | | | | K--FDTVLG-TVSSACQATALSSFLNACVAASRATAG | | | | | |
| <i>HKU5</i> | ALL-LDCA-VLTGASAYFVARY-VDE | | | | | | K--VEQLTN-LVFSSCQSAVAAFVQACMSTYKATAK | | | | | |
| <i>HKU9</i> | YLA-YTTG-RVTLFSAYQVLNT-AIA | | | | | | K--SKDAFG-GVAIVVDMLKPILEWVWKMSIAKG | | | | | |
| <i>Hedgehog-CoV</i> | QLL-FNCV-EISAASMYFASVV-IRE | | | | | | K--VNTMFN-ALPLSVQTAANKFIDVCLRATLCTVK | | | | | |
| <i>MERS-CoV</i> | ELL-FDCV-DLSVASTYFLVRI-LQD | | | | | | K--TGDFMS-TIITSCQTAISKLLDTCFEATEATFN | | | | | |
| <i>MHV</i> | DMA-LLFMHDVKVATKY | | VKK | | | | V--TGKLAV-RFKALGVAVVRKITEWFDLAVDIAAS | | | | | |
| <i>OC43</i> | ELL-DVSLDSLGAIAIH | | LNS | | | | K--IVDLAQ-HFSDFGTSFVSKIVHFFKFTTSTAL | | | | | |
| <i>Rat-CoV</i> | DMA-LLFMHDVKVATKY | | VKK | | | | F--TGKLAV-RFKALGVAVVRKITEWFDLAVDIAAS | | | | | |
| <i>SARS-CoV</i> | YTS-DLLT-NSVIIMAYVTG-G-LVO | | | | | | O--TSOWLS-NLLGTTVEKLRPIFEWIEAKLSAGVE | | | | | |
| <i>229E</i> | L---FVNDKITEFQLDY---SIDVID | | NEIIVKPNISLCVPLYVR | | | | DYV---DKWDD---FCRQYSN---ESWFEDDYKAFISVLDITD---AAV-KAAES---K | | | | | |
| <i>Bat-CoV-1A</i> | REVRATLGFVSRVYDKY---NCVVKD | | GKCVVTHRYVFNAPSVE | | | | DKA---IFVD---LCKDYVA---DVGFEAFYANAIVANNSDE---FNP-VYSAF---E | | | | | |
| <i>BtCoV512</i> | VKVDTLFNYDKIYKYY---STIIKG | | DRCYIQTHTFKAPSYF | | | | DD---DEFVE---LCTRYK---LPDFAFYNAVHAATDMDQFCALC---TSGF---E | | | | | |
| <i>BtMr-AlphaCoV</i> | | | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | | | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | KTTVEQLVKFNTPYRNY---DVSVVN | | NKCVKCTYTFRAPAYIA | | | | DTE---NFVK---ACEVCVD---KEGFDEFYVQTHAVDSLVA---FKP-AFAEF---E | | | | | |
| <i>CDPHE15</i> | VKVDQLLPNYSTSYKRY---ESVIRG | | EQCFIRCIYDFRAPSFRKG | | | | DDA---EKFKV---QCEVLVS---NPLFFEFYTOAHEAVDLQYVNTACTLEGF---S | | | | | |
| <i>FCoV</i> | AKVNDLLIEFRQEKLCFRA---LKD | | ENILVEAYLKKYKMPVCLK | | | | NHV---GLWD---IIRQDSG---KKGFLDTFNHLNELEDVKD-----I | | | | | |
| <i>Ferret-CoV</i> | SKLNTALQVYYDNALCFRA---FSLK | | ETIVVEPFQHKYKMPKCLK | | | | NHT---GLWE---IILSGSK---DLGFFDKYKALESLEADIDYD-----T | | | | | |
| <i>HKU10</i> | SDVTKQLLPLNKPYPFY---DVKVKD | | GMCIVTQETTFRAPSIA | | | | NSA---LFVQ---LCEECVD---VQGFDDFYVKAHEATSLSQ---FEP-MFPAF---Q | | | | | |
| <i>HKU2</i> | QTVANKVQAFNNRFVY---NAHVVD | | GAINVFCDYKFCPAFLD | | | | GFP---EWFs---FCKNHFK---DAGFVEFYDCIINSSTFTQTTFQP---YLDL---K | | | | | |
| <i>HKU8</i> | HEVKKILGGIARPYDKY---TCSVIN | | GECQVDHSYNFKAPAYIT | | | | DKQ---QFVM---LCKDFV---DAKFEFVYKALEAKSLDG---FEP-YEAF---T | | | | | |
| <i>LuchengRn-CoV</i> | SFLRKSLSKGFHNFDDFEYMQGKIEKLRQAVAAAEYDFEICEYIYSCNGTYEMAHTMRISFSD | | DDDPIMEELVAVSEECADDAAE | | | | ESGANADDVDDVDSVADETDVADDCVQSDPVT | | | | | |
| <i>Mink-CoV</i> | ESLNVALKEFYNSGVCFKA---YADK | | DIIVIEPFCRKYKMPKCLR | | | | DHT---GLWD---IIRSNAG---EPGFNFKYKLEALEDVYD-----S | | | | | |
| <i>NL63</i> | IAVELLLLDKFTAVFVY---TCVVDG | | CSVIVRRDATFATHVCFK | | | | DCY---NVWEQ---FCIDNCG---EPWFLLTDYNAILQSNPQC---AIV-QASES---K | | | | | |
| <i>NL63-related</i> | AAVELLLSDFKNAVFVY---NFSVDG | | CNIIVKRDVAFATPLLFK | | | | DCY---SVWEN---FCIDYCG---QPWFLLVDYNSILQGTSLSD---IVV-QASES---K | | | | | |
| <i>Porcine-EDV</i> | VQTDLLKKNYNTPYKTY---SCVVRG | | DKCCITCTLQFKAPSYVE | | | | DA---VNFVD---LCTKNIG---TAGFHEFYITAHEQQDLQGLFTTCCCTMSGF---E | | | | | |
| <i>TGE</i> | VKVNELLIEFROOSLCFRA---FKDD | | KSIFVEAYFKKYKMPACLA | | | | KHI---GLWN---I IKKDC---KRGFLNLFNHLNELEDIKE-----T | | | | | |



1020 1030 1040 1050 1060 1070 1080 1090 1100 1110 1120 1130 1140

Bat-BCoV ----TIFDLKAFISL-----IVRNKY-----KFVKGKVFLLAKNVSSVVQSVVAYLNNVISAFY-----QQVQFAGTYVGF-ETHQTLLELGGAIYTRV-----QVAAN

Bovine-CoV ----A---FAWVLFH-----VLHGAY-----IVVESDIYFVK-IPRYASAVAQAFRSVAKVVL-----DSLRTFIDGLSCFKIGRRRICALSGSKIYEVEGLLHSSQLPLD

Covid-19 ----FLRDGWEIVKF-----ISTCAC-----EIVGGQIVTCAKEIKESVQTFFKLVNKFALCA-----DSIIIGGAKLAL-NLGETFVTHSKGLYRKC-----VKSRE

GCCDC1 ----SVVNCAEAVLS-----LFNMQF-----TFAGKFTFLKEKLNKSCVALRELLTVIVNKFA-----TTVKWAGCKIDGF-YNGDYHFFSAKGVLTVEV-----QVCAK

HKU1 ----A---TGWLLYQ-----LLNGLF-----VVSQANFNVAL-IPDYAKILVNKFYTFKLLL-----ECVTVDVLKDMPLVLTINGLVCIVGNKFNVSTGLIPGFVLPNC

HKU14 ----A---FAWVLLH-----VLRGAY-----IVVESDIYFIMS-IPDYARVVVTRFQNVFKMAL-----DCVKVSFLKGLSAFKIGREKICFVGSKFYKVERGNLNDLV----

HKU24 ----A---LAWVVLH-----VINGAY-----LILEDGFHFVGS-VPDYARNFVRIILREVMNML-----DCMKHTIIKGLPCFKVAAEYIVFSGSFVYKGLGLAMIDNLVLPD

HKU4 ----FINDMFKLFV-----LMHKLY-----VYTSCGYVAVAEHSSKIVQQVLDIMSKAMQLLH-----TNVSWAGTKLSAIIYEGREALLFNSGTYFCL-----STKAK

HKU5 ----FISDMFTLIKV-----VSERLY-----VYTSVGFVVGDYSSQLLKQFMHILSKAMQLLH-----TTVSWAGSKLPSVVYNGRDSLVPFSGTYFCV-----STQGR

HKU9 ----AWLPYAEGLLA-----LFKAQF-----TVVKGKQFLRASLNSKCHSLCDLLTTIMSKLL-----TSVKWAGCKVDAL-YTGTYYFYSRKGVLTEV-----QLCAK

Hedgehog-CoV ----FLNDLLSLVKL-----VVYKAF-----VYTSAGFVSTLEKTSPPAAQKLLDVLKAFKLLH-----KKVSWAGSKVHAVIYEGKDALVFSSGTYHCV-----TAPGS

MERS-CoV ----FLDLLAGLFRI-----FLRNAY-----VYTSQGFVVVNGKVS TLVQVLDLLNKGMLLH-----TKVSWAGSKIIAVIYSGRESLIFPSGTYFCV-----TTKAK

MHV ----A---AGWLCYQ-----LVNGLF-----AVANGVITFVQE-VPDLVKNFVDFKFAFFKVL-----DSMSVILSGLTVVKTASNRCVLAGSKVYEVVQKLSAYVMPVG

OC43 ----A---FAWVLFH-----VLHGAY-----IVVESDIYFVK-IPRYASAVAQAFQSVAKVVL-----DSLRTFIDGLSCFKIGRRRICALSRKIYEVEGLLHSSQLPLD

Rat-CoV ----A---AGWLCYQ-----LVNGLF-----AVANGVITFVQE-APDLVKNFVDFKFAFFKVL-----DSMSVILSGLTVVKTASNRCVLAGSKVYEVVQKLSAYVMPVG

SARS-CoV ----FLKDAWEILKF-----LITGVF-----DIVKGOIQVASDNIKDCVCKFIDVYVNKALEMCI-----DOVTIAGAKLRSL-NLGEVFAOSKGLYROC-----IRGKE

229E AFVDTIVPPCPSILKVIDGGKIWNGVIKNVNYVRDWLKSLKLNLTQQGLLGTCAKRFKRWLGLILLEAYNAFLNTVV-----STVKIGGLTFKTYAFDKTYIV--IRDIVCKVENKAEAEWI----

Bat-CoV-1A VFK--TKVECPPEEFMIDGGSIFGTINTVNDAVNFVSKLITVTATEVMINTVKRFRFASALAKLYSEFMNTVK-----NIIISIGSIKCYHYGFVKPVLV--IKDIFYRIYDAAVDT-----

BtCoV512 VFI--PRVPDCPPILNDIDGGSIWTSFILSVRSATDFIKTLKIDLGLNGVVFVTKKFRKAGALLQKLYNAFLDVT-----SFIKVAGVAFKYCATCVPKIV--INGCYHTVTRLFAKD-----

BtMr-AlphaCoV TLA--GAVECPSLQVQVGGAIWRKVVSVFDGVTDFLKNLKIQFGLNGFVGTCAKRYRILNLTLLTMYNDFAAASVR-----QVVVLAGVKLSYYAFETPAVA--LNGVLHAVKRCSAKS-----

BtNv-AlphaCoV ----TIVCPDVLAVDGGDIFHKFLSTVTDVVEFCASIKVHFGLEGFVITAAKFKAFARTLLENLYNEFAIAVS-----DVVKIACMNFTYYAFNKPMVA--VNGTLCPELVE--PP-----

BtRf-AlphaCoV QFL--EPVSCPFLFLEIDGGNIWNKFIKTVTDAVEFVKSIVSFDLNGVVKATKRFKRAATLVNLYREFVATVT-----KTIKIGSQAFYYAFVPEVKV--LSGALHSVTVKAKE-----

CDPHE15 HMA--PAVPKPHPLFLQIDGGAIWRSVVRVSAVADFVRNLKVSFGLGIIVSAARKFKQWAKLLAQMYNEFLNSVS-----AAIHAGVKFIHYATVTPQLA--YNGCLYALKKTYAAT-----

FCoV KIQTIKNIIICPDLLLELDFGAIWYRCMPACSDKSIL---GNVKIMLNGVVKVDCGHSFANRLTINYNKLCDTAR-----KDIEIGGIPFSTFKTPSS-SFIDMKDAIYSVE-----

Ferret-CoV N--DYANLVCPKLLHKLDNGIMWYRCMKGVTPGIVT---RAACSFVGCVKVCEGFDVAARVEVCYQKLCGIKT-----FDLNVAGIVFAGFKTPSGKTFDFGDDAIELFD-----

HKU10 QFV--KSDVCPQILKIDGGGIWKTFIQTVSDAVEFVKSIVKDFGLDGIITATKRFKFKAGILLNLYREFIASVT-----SVVKIGGKSFTYYLFEKPKMA--ISGILHNVRVLKAD-----

HKU2 P--SVDAYLGPEIVRAVDGGRLRRTVINGIGDAVNFCKNLRHLHFEGELKGTVVKRFKILGTLTLLTVYNEFIQTTV-----SVLTICGISAKYYAFDKPMLC--MHGITERVTSFDITS-----

HKU8 IFK--GELKCPAELIELDDGGLFNTFIKTVNSAYDFVKNLKVSVTVKGVICTAARKFRWANALAKIYTEFITGAC-----KTVVIGGLEFAYYCFAPKPAIA--LGDIFVRVSKNLSA-----

LuchengRn-CoV QESDSVEIDCAPLESTIADDTLYLGRSEFWKNHWN-----LDCKPMVSKEVEGMKFWF---PAFNEWNCTIRT LAVFVGMFRLAGDDLKWCMDMELQKLW-----

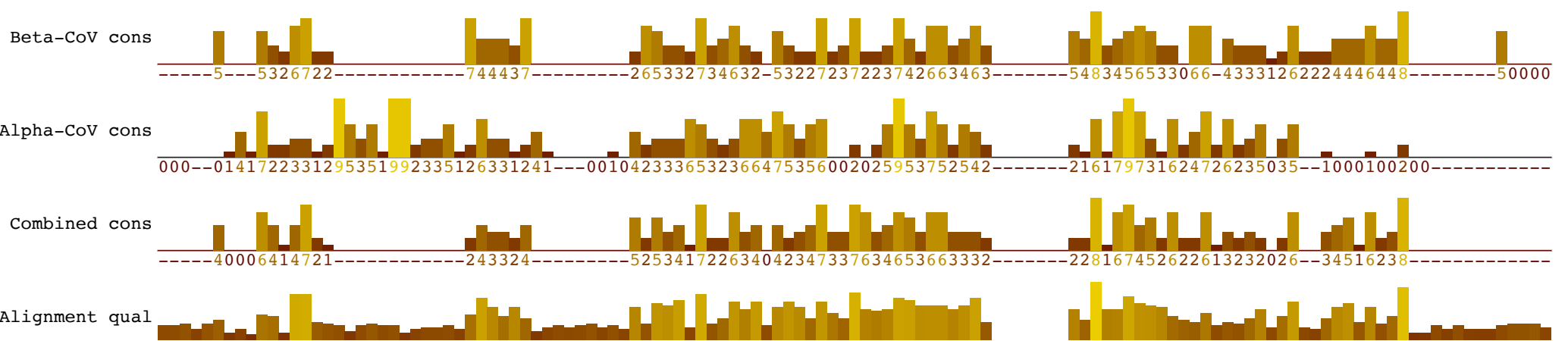
Mink-CoV D--DYKNLLCPKVLFRLDNGI IWYRHIRSVKNCKIT---HVTCTFTGGILKLLLDGYDALAGMITRGYQQLCKAKP-----FKLDIAGVTLNGFTTPIGRDFLDFGEDVVEIFC-----

NL63 VLLERFLPKCPEILLSIDDGHLWNLFVEKFNFTDWLKTLLKLTLSNLLGNCAKRRRVLVKKLLDVYNGFLETVC-----SVAYTAGVICIKYYAVNVPEYV--ISGFVSRVIRRERCD-----

NL63-related ALLEHLNPKCPDVLNIDGGRLWKMVFQKLDVVEWLKTLKLTLPKLLGNCAKRFKRLAKLLDIYNGFLETVC-----SVVHTAGVAIKHYAVDVPYV--IGDFVSRVVKCKRAD-----

Porcine-EDV CFM--PTIPQCPAVLEEIDGGSIWRSFITGLNTMWD FCKRLKVSFGLDGI VVTVARKEFKRLGALLAEMYNTYLSVTV-----ENLVLAGVSFKYYATSVEPKIV--LGGCFHVSCKSVFASV-----

TGE NIOAIKNILCPDPLLDLDYGAIWYNCMPGCSDPVSL---GSVOLLIGNVKVVDGCKGFANOLSKGYNKLCAAR-----NDIEIGGIPFSTFKTPN-TFIEMTDIYSVIE-----



1150 1160 1170 1180 1190 1200 1210 1220 1230 1240 1250 1260

Bat-BCoV S---IQDLVLPSTVSK---KELTFVDGHAIDT---ELTSEEVTVLEGIIVEQLDSTDNTNKIAGDSIKGLDLTVVNNCVFVRFGDG--NL--SPATTD-----C---QATKG-----V

Bovine-CoV V---YDLTMPSQVQK-AKQKPIYLKSGSDF---SLADSVVEVVTTSLTPC---GYSEPPK-VADKICIVDNVYMAKAG---DKYYPVVVD-----L

Covid-19 E---TGLLM-PLKAP---KEIIFLEGETLPT---EVLTEEVLKGTGDLQPLEQPTSEAVEAPLVGTPVCINGLMLEIKDT--EKYCALAPN-----M---MVTNN-----T

GCCDC1 T---LGAMLTTPRQQR---MEVEVLGKYDAP---VAITVPELEELNGTLEEVEFG---FDDLTLVRGSLVALASKVFLRTDDG--LLFRYVKSQ-----G---V--FLK-----A

HKU1 A---QE---QOIYFFEGVAESV---IVEDDVIENKSSLSSY---EYQPPK-SVEKICIIDNMYMGKCG---DKFFPIVMN-----D---KNIC-----L

HKU14 R---RDLVVPSVTQRAKNQPPVYLTGNCAPV---NVDDDVEVVVTPNPTSC---GYQKPPQ-KCDKICIVDNVYMAKCG---EKFFPVVVD-----E---DYIG-----L

HKU24 M---IQ---SELLALHGDIVIPV---TLESEVVEVVQPLKPL---GYRKPMM-KAARLCVVDNLYMAQNG--DCLYPVIFD-----G---QRIG-----L

HKU4 TLQGQMNVLVPGDYNK---KTLGILDVPPNADTIDVNAVSTVDDVVGQLE---PTNEHGSPMIVGNVYLVSDKLFVTRTEDE--EFYPLCTN-----G---KVVST-----L

HKU5 SLQDQFDLVIPGDLSK---KQIGILEPTPNSTTVDKKINTNVVEVVVQLE---PTKEHSPELVVGDIYIISNKIFVRSVEDSETVFYPLCTD-----G---KIVPT-----L

HKU9 R---LGLLLTPKQK---MEVEVLGDFDAP---VLTLDLELEECTGVLEEVFG---ASDVKLVKGLVSLASKLFVRTEDG--FLYRYVKSQ-----G---V--LGK-----A

Hedgehog-CoV VVGAHLEATIPGEVVK---KQLSMLTATNYSTTVDRPKTRNVELVYGQLE---TTNMHSPDVVGDYIVVSDKVFVRSEEDGRLAFYPMCTN-----G---KAVPC-----M

MERS-CoV SVQQDLVDVILPGEFSK---KQLGLLQPTDNSTTVSVTSSNMVETVVGQLE---QTNMHSPPDIVGDYIISEKLFVRSKEEDGFAFYFACTN-----G---HAVPT-----L

MHV C---SE---ATC---LVGEIEPA---VFEDDVEDVVKAPLTYQ---GCCPKPT-SFEKICIVDKLYMAKCG---DQFYPPVVVD-----N---DTVG-----V

OC43 V---YDLTMPSQVQK-AKQKPIYLKSGSDF---SLADSVVEVVTTSLTPC---GYSEPPK-VAKICIVDNVYMAKAG---DKYYPVVVD-----L

Rat-CoV C---SE---ATC---LVGESEPA---VFEDDVGKVTPLTYQ---GCCPKPT-SFEKICIVDKLYMAKCG---DQFYPPVVVD-----N---DTVG-----V

SARS-CoV O---LOLLM-PLKAP---KEVTFLEGDSDHT---VLTSEEVLKNGELEALETPVDSFTNGAIVGTPVCVNGLMLEIKDK--EOYCALSPG-----L---LATNN-----V

229E -----ELFPHNDRI---KSFSTFESAYMPIADPTHFDIE-----EVELLDA---EFVEPGCGGILAVIDEHVYKKGK---VYYPNGT-----NILPV-----A

Bat-CoV-1A -----FNVAVEAGL---NTVKTFSGGENPI-TFSRVEVA-----SVELEHA---EYVKPEANGHVSVINGHTFYTCGD---YYPCDQN-----NCFSQ-----C

BtCoV512 -----LQIPTEDGV---ADFNTFNHCVPVP-NPTRIETD-----SLELEEV---DFVEPGVDGKLVILDDYSFYSDGT---NYYPGSDGK-----GVAS-----C

BtMr-AlphaCoV -----LDVPCEEGA---AEFNVFEGGVHLL-KPTAVELA---SDMELLEET---DYVEPCAGGVLRICDDYAWYMDGD---RFYYPGDN-----GVIPL-----C

BtNv-AlphaCoV -----SDVSKEALV---TDFMVFKSPDTHV-KPIRIETE-----SCELHEV---DFVTPRDGGVVKIIDGYAFYESNG---NYYPSSVD-----GKKNV-----T

BtRf-AlphaCoV -----LNLVSVQDVV---VEFNVFDGATVEV-TPKRVEKE-----EVSLEEV---EFIPVSNNGSIAVVDGYSFYSCGD---LYYPSNEN-----AVVPL-----C

CDPHE15 -----VGLQTEEGV---DGFYAFDHCQLPV-TPRLLQVE-----DVNLEEA---DFKPPVGGGCVAVINGYSFYVEGD---SYPTDCS-----AIHSL-----R

FCoV -----Y---GEALSFKTASVPVTNSGIITDDW-SDPILLEPA---DYVEPKDNGDVIVIAGYTFYKDED---DHFYYPGSG-----M

Ferret-CoV -----D---EPVRCFTGATVPVNVSD-EDDVR-GDVV-LEEC---EYQPPRDEGIVVNLGGYTFYTTDN---EKFYFPGDC-----KVVPK-----L

HKU10 -----CTIAAEDIL---VEMTVFDSFEIPI-QPSRVEVQ---QVEFEEA---EFVQPQAGGVLAVNVKHVFNKGD---YYPANET-----HAVPV-----C

HKU2 -----LGKPILDGL---SRCNVFARGSNV-VVDSVDHE---LLDLEEC---DFVEPASHGVLVVSDDYGFYSCET---GIYPYASD-----G---KVLPL-----R

HKU8 -----FNRPTTEAGA---VDALVFEGGDIET-VCSRVDQFD---TVALEPV---QEVVPSDGYVAVVDGYTFFTDGT---HYFPTGLS-----RCYTT-----C

LuchengRn-CoV -----ETKSQYLWYKLA---AAEPDKVERGNEGSYSGNGMDYNTVFRVALRKLKLSNAKAC

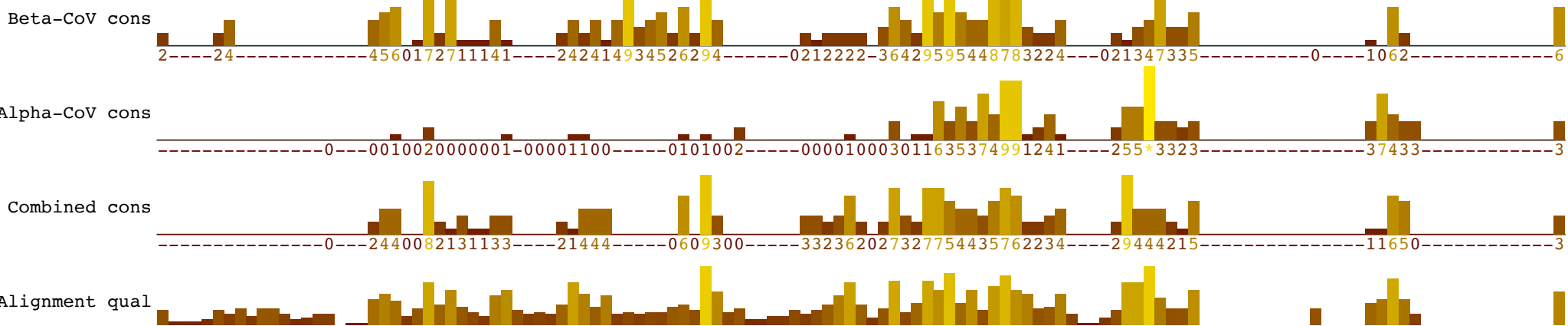
Mink-CoV -----G---GKTRCFSGASIPVSVEKIVEDDVW-STTI-LEET---EYQPPKNGGVVVVIDGYTFYTCNH---EQFYFPGDS-----KVVQK-----L

NL63 -----MTFPCVSCV---TFFYEFLDTCFVSKPNAIDVE---HLELKET---VFVEPKDGGQFFVSGDYLWYVVD---IYYPASCN-----GVLPV-----A

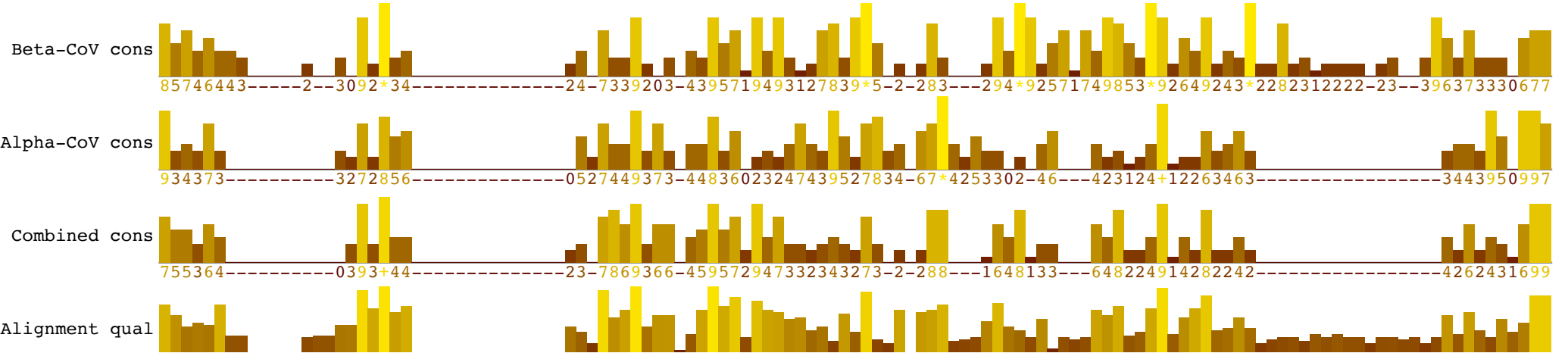
NL63-related -----VPVPCDSRI---TSFHFEVDAVYKVKPPTIDVE---HLELKET---SFVEPKEGGFVVSDDYFWYIMDD---ICYPASED-----GVLPV-----A

Porcine-EDV -----FQIPVQAGI---EKFKVFLNCVHPV-VPRVIETS---FVELEET---TFKPPALNGGIAIVDGFYFYDGT---LYYPTDGN-----SVVPI-----C

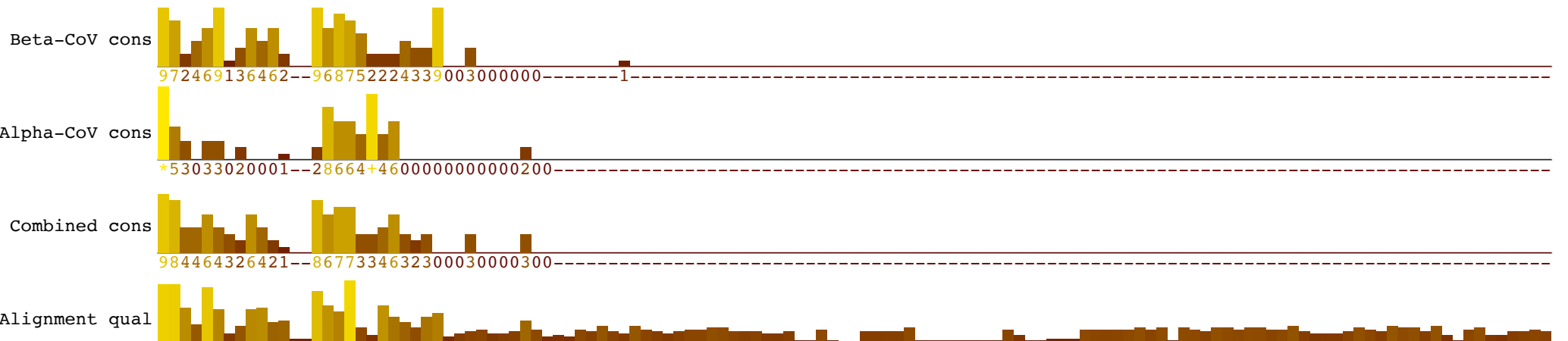
TGE -----O---GKALSFRDADVPVVDNGTISTADW-SEPILLEPA---EYVKPKNGNVIVIAGYTFYKDED---EHFYYPYFGF-----KIVOR-----M



| | 1280 | 1290 | 1300 | 1310 | 1320 | 1330 | 1340 | 1350 | 1360 | 1370 | 1380 | 1390 |
|----------------------|--|-----------------|--------------|---------------------------------|---------------------------|---------------------------|-----------------------------|-------------------|------------------------|---------------------|------|------|
| <i>Bat-BCoV</i> | FKLKGGNP | DKVKTVTFGE | NE-VKEITPY | ITVNVKVTVDHLLDKILN | V-RLP | SFTVEKGLTLOELTAVVEDAVVTQ | LEAMRAILLEA | GVDIDIDDL | IDSPYYM | | | |
| <i>Bovine-CoV</i> | LDQAWRVP | CAGRRVTFKE | QPTVNEI | ASTPKTIKVFYELDKDFNTILN | T-ACG | VFEVDDTVDMEEFYAVV | IDAIEEKLSPCKELEGV | GAKVSAFLQKLEDN | SLFL | | | |
| <i>Covid-19</i> | FTLKGGAP | T-K-VTFGD | DT-VIEVQGY | KSVNITFELDERIDKVLN | E-KCS | AYTVELGTEVNEFACVVADAVIKTL | QPVSELLTPI | GI--DLDEWSMATYYL | | | | |
| <i>GCCDC1</i> | FRLRGGGK | P---KVSFGE | EE-VRTVPRV | LTVNFTYDVCEGLDGVLN | K-LMA | PFVEVEGKTKLEDLALVV | QEAVAEKLRELFD | PCPAD-VRPIDIDAFAD | DECYI | | | |
| <i>HKU1</i> | LDQAWRFP | CAGRKNVFNE | KPVVMEI | PSL-MTVKVMFDLSTFDDILG | K-VCS | EFEVEKGVTVDDFVAVV | CDAIENALNSCKEHP | VVGYQVRAFLN | KNENVVYL | | | |
| <i>HKU14</i> | LDQAWRFP | CAGKKISFVE | EPSVKEI | VTK-KTVKVCFELDANFNTILD | T-ACS | VFEVDNTVDMEEFAAVV | ADAIEEKLTPCKEL | DGVGIVKSAFLQKLEDN | NLHF | | | |
| <i>HKU24</i> | LDQAWRFP | CAGKSVSFAA | ADDVKII | IA-AKKKVTVEYDLDFEFNTILN | T-ACN | SFEVDGSDVADELA | AVIVDTIQDKLES | CKTLEGVGA | VCAFLSRLDEEPIYL | | | |
| <i>HKU4</i> | FRLKGGMP | S--KKVTFGD | VN-TVEVTAY | RSVSITYDIHPVLDALLSSS | KLA | TFTVEKDLLVEDFV | VDVIKDEVLTLL | TPLLRYG | IDID-GF--DVEDFIDVPCYV | | | |
| <i>HKU5</i> | FRLKGGAP | P--KGVKFGG | EQ-TKEITAV | RSVSDYDVHPVLDALLAGS | ELA | TFTVEKDLPVKDFV | DDVVKDEVIELL | SKLLRGINVD | GF--DLEDFADTPCYV | | | |
| <i>HKU9</i> | FRLRGGGV | S---KVTFGD | EE-VHTIPNT | VTVNFSYDVCEGLDAILD | K-VMA | PFQVEEGTKLEDLAC | VVQKAVYERL | SDLFSDCPAE | LRPINLEDFLTSECFV | | | |
| <i>Hedgehog-CoV</i> | FTLKGGAP | I--KKVSFGN | DE-IHEIDAV | RTVTVEYNIHPVLDLTL | SNT-ELK | TFVVDKDLTVSEF | ALVVQEA | VADLLAKLLR | GIALD-DF--DLEDFIDTKVYV | | | |
| <i>MERS-CoV</i> | FRLKGGAP | V--KKVAFGG | DQ-VHEVA | AAV-RSVTVEYNIHAVLDTLL | ASS-SLR | TFVVDKSL | SIEEFADV | VKEQVSDLL | VKLLRGMPI | IP-DF--DLDDFIDAPCYC | | |
| <i>MHV</i> | LDQCWRFP | CAGKKVEFND | KPKVRKI | PST-RKIKITFALDATFDSVLS | K-ACS | EFEVDKDVTLDE | LLDVLD | AVESTL | SPCKEHDVIGTKV | CALLDRLAGDYVYL | | |
| <i>OC43</i> | LDQAWRVP | CAGRRVTFKE | QPTVKEI | IISMPKIIKVFYELDNDFNTILN | T-ACG | VFEVDDTVDMEEFYAVV | IDAIEEKLSPCKELEGV | GAKVSAFLQKLEDN | NPLFL | | | |
| <i>Rat-CoV</i> | LDQCWRFP | CAGKKVFN | KPKVKEVP | ST-RKIKIIFALDATFDSVLS | K-ACS | EFEVDKDVTLDE | LLDVLD | AVESTL | SPCKEHDVIGTKV | CALLDRLAEDVYL | | |
| <i>SARS-CoV</i> | FRLKGGAP | I--KGVTFGE | DT-VWEVOGY | KNVRITFELDERVDKVLN | E-KCS | VYTVESGTEVTEFAC | VVAEAVVKTLP | OPVSDLL | TNM-GI--DLDEWSVATFYI | | | |
| <i>229E</i> | FTKAAG | -----GKVSFSD | DVEVKDIEPV | YRVKLCFEFEDEKLV | DVCEK-AIGKKIKHEG | DW---DSFCKTIQSALS | VVS-----CYVNLPTYYI | | | | | |
| <i>Bat-CoV-1A</i> | FKKVGG | -----SAVTFSE | KVAVKQIDPV | YKVKLVFEFEDDTISS | VCKQ-AIGKYISFEGNDW | ---SSFETIHNAMNVG | -----EFVDLPDYFI | | | | | |
| <i>BtCoV512</i> | FKKKGG | -----GVVTISD | EVQVRTIDPV | YKVRLEYEFEDETLV | KVCKE-AIGTKLKVGTG | DW---SNLLETLEKAMD | VVR-----QHLDPDYFV | | | | | |
| <i>BtMr-AlphaCoV</i> | YKLGGS | -----DRVTFGE | DEIKEIPAR | NNVKLI | FEFENDVIAEACKQ-AIGKRISFEG | DW---SDLCEMIDIAMKALS | -----DHIEVPEYYI | | | | | |
| <i>BtNv-AlphaCoV</i> | YRKKGG | -----GVVTFSE | TNSVKEVDPV | HKVYLTYEFEDEVV | EVLKQ-TVGYKMTFEGQEW | ---ADFEATLRGVLS | VVS-----TKLPIPEYFV | | | | | |
| <i>BtRf-AlphaCoV</i> | FKRSGG | -----GKLQFSD | VVEVKEIDPV | YKVKLDYEFEDENIA | AVCKK-AIGSKIYNGSDW | ---EGFCEQIHSVMT | VVG-----EHMELPKYYI | | | | | |
| <i>CDPHE15</i> | FRKLG | -----AGVAFSE | DVAVKTIDPV | YKVRLEDFEFEDDS | VVALCKK-TIGKSIKFN | TEW---DKFVAILE | TALGVLA-----KHVTLPPYFI | | | | | |
| <i>FCoV</i> | YNKMG | -----GDKSVSFS | D | NVREIEPV-TRVRLEFEF | DNEVVTVQVLEK-VIGTKYKFIG | TTW---EEFEDSISEK | LDKIFDTL-----AEQVLEGEYFI | | | | | |
| <i>Ferret-CoV</i> | YNKAGG | -----G-KNVTFSD | DVEVREVPV | FKVKVTFEFD | DDTITGVLTN-VIGNTMTFEG | DSW---ETLENLLT | TQVDAVFKQL-----AQAGLTPDYI | | | | | |
| <i>HKU10</i> | YKRGSG | -----TNGTVVKFSE | AVQVKEIPV | HRVKLEYEFED | ETIVEICKK-VIGKRYKFTG | TEW---EELCSY | IHSVMKTVS-----DHIEVPEYFV | | | | | |
| <i>HKU2</i> | FRKKAG | -----GKNVAFDD | NVTVEIDPI | FKVKLSFEFEDEK | LIECKK-VIGSKVKC--SSW | ---SQLVEIID | TALTATK-----SYNVPEYFI | | | | | |
| <i>HKU8</i> | FKRGG | -----GTVEFSE | VVEVKEIDPV | YKVRLEYEFEDENIA | IVCKK-AIGKIITFE | TDW---SEFEQTLIN | AVSVVG-----EFVDLPDFYV | | | | | |
| <i>LuchengRn-CoV</i> | WVCKCAQVELDGLDACVGHFSKVQCLCGAIMVARELKVPFELIAPG-YAMGP | --- | VDIALSRACVVA | AIGYMATAHTSAVHVHGARPLLIDDDNDVAF | | | | | | | | |
| <i>Mink-CoV</i> | YNKSGG | -----DVKNVTFND | TVDVREVPV | FQVKITYEFDDTIT | NVLKT-VIGTSVTIEG | NNW---ELDDTL | TEKVDVFSQL-----QQAGIELPSYYI | | | | | |
| <i>NL63</i> | FTKLAG | -----GKISFSD | DVIVHDVEPT | HKVKLIFE | FEDDVVTSLCKK-SFGKSI | IYTG-DW---EGLHEV | LTSAMNVIG-----QHIKLPQFYI | | | | | |
| <i>NL63-related</i> | FSKSAG | -----GKISFAE | EVTVHDVEPT | HKVKLVFEFDDN | VARLCKK-SLGSIMYTG | DW---DGLCKML | TSAMNVIG-----QHVTLPQFYI | | | | | |
| <i>Porcine-EDV</i> | FKKKGG | -----GDVKFSD | ESVKTIDPV | YKVSLEFEFESE | TIMAVLNK-AVGNRIKVTG | GW---DDVVEYIN | VAIEVLK-----DHVEVKYYI | | | | | |
| <i>TGE</i> | YNKMG | -----GDKTVSFS | EVDVOE | IAPV-TRVKLEFEF | DNEIVTGVLER-AIGTRYKFTG | TTW---EFEESISE | ELDAIFDTL-----ANOGVELEGEYFI | | | | | |

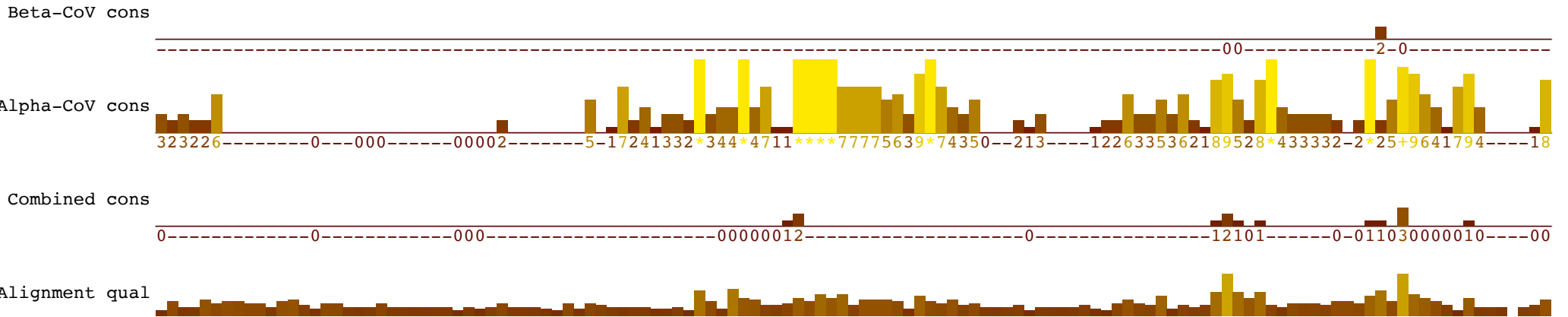


| | 1400 | 1410 | 1420 | 1430 | 1440 | 1450 | 1460 | 1470 | 1480 | 1490 | 1500 | 1510 | 1520 |
|----------------------|---|------|------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | FDNAGDSVIGPV--MYFSNQPVDSDELTTASETEEVVEDAKHAAT-----K-----R-----SSQDWLD--DS--CSEDDCEEEDAVTEAESAA-----DSAP | | | | | | | | | | | | |
| <i>Bovine-CoV</i> | FDEAGEEVLASK--LYCAFTAPEDDDFLEESGVVE--DDVEGEET--DLTVT-----S-----A-----GEP----- | | | | | | | | | | | | |
| <i>Covid-19</i> | FDESGEFKLASH--MYCSFYPPDEDEE--EGDCEEEFEPSTQY-----EYGTEDDY----- | | | | | | | | | | | | |
| <i>GCCDC1</i> | YNMDYEKVLSTE--MYFSLEDVTPVEDEDECASEVQSSDDCEE-----Q----- | | | | | | | | | | | | |
| <i>HKU1</i> | FDEAGDEAMASR--MYCTFAIEDVEDVISSEAVEDTIDGVVEDTINDDDEVVTGDND--E--DVVTG-----DN----DDEDVVTGDNDDEDVVTGDNDDEDV--TGDNDDEDVVTGDND | | | | | | | | | | | | |
| <i>HKU14</i> | FDEAGDCVLASK--LYCTFSAPIDEDFGES--EYEE--GDVDVDET--DSIVT-----S-----T-----S--QEVCAAGSGIP----- | | | | | | | | | | | | |
| <i>HKU24</i> | FDECDEKVVSSH--MFCTFCPPEDDDVVMFECEAEGCDLSEVET--PEAVEAEPASQ--S-----D-----SQYGNVDGNGVGDVKAVDVAVETEAVV--NSES-----EQ | | | | | | | | | | | | |
| <i>HKU4</i> | YNQDGDCAWSSN--MTFSINPVEDVEEVE--EFIED-----DYLS-----D--ELPIA-----D--DEEAWAR--AVEEVMLDDILVAEIELEEDPPL--TALESVE | | | | | | | | | | | | |
| <i>HKU5</i> | YNAEGDLAWSST--MTFSVNPVEEVEECCDDDYVED-----EYLS-----E--EMLVE-----E--DENSWAA--AVEAVIPMEDVQLDTLVAEID--VSE--PADDDVAE | | | | | | | | | | | | |
| <i>HKU9</i> | YSKDYEKILMPE--MYFSLEDVAVPVDDDEMVD-----DIED-----T----- | | | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | FNLDGDEVVKST--MIFSVHPVDCDDEEIDDAL--EED-----D--SFNEE-----E--EPDSWAE--MVDIAIFPLSDEAEGDVVVEEQSLVD--DAGVVSP | | | | | | | | | | | | |
| <i>MERS-CoV</i> | FNAEGDASWSST--MIFSLHPVECDE--ECSEVEASDLEEGESECEIS--E--TSTE-----Q--V--DVSHE-----T--SDDEWAA--AVDEAFPLDEAEDVTE-----SVQE | | | | | | | | | | | | |
| <i>MHV</i> | FDEGGDEVIAPR--MYCSFSAPDDEDCVAADVVDADEN-----Q-----DDDAED--S--AVLVA-----DT--QEEDGVAK-----GQVEA-----DSEICVAHTGSQ | | | | | | | | | | | | |
| <i>OC43</i> | FDEAGEEVLAPK--LYCAFTAPEDDDFLEESDVEE--DDVEGEET--DLTVT-----S-----A-----GQP----- | | | | | | | | | | | | |
| <i>Rat-CoV</i> | FDEGGDEVIAPR--MYCSFSAPDDEDCVAADVVDADEN-----Q-----DDDADD--S--VVLVA-----DA--Q--EDGVAK-----EQVEV-----DSEICVAHTGGQ | | | | | | | | | | | | |
| <i>SARS-CoV</i> | FDDAGEENFSSR--MYCSFYPPDEEEDDAECEEEFIDETCEH-----EYGTEDDY----- | | | | | | | | | | | | |
| <i>229E</i> | YDEEGGNDLSLP--VMISEWPLFESDKEEDVQQAQQ----- | | | | | | | | | | | | |
| <i>Bat-CoV-1A</i> | YDEEGGHDLTNT--VMISQWPV-----FDPSALQLLVADLGVNCFNGKSSIEECLTSV-----SDTVLCVSLKSCDCGTFNAIMEG----FALDFKPCTDSDVDCNCGG--F--CT----- | | | | | | | | | | | | |
| <i>BtCoV512</i> | YDEEGGTDLNL--IMVSQWPLSSDSEDD----FKAVDDE-----PNA-----NTDETVD-- | | | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | YDEEGGNDLDP--VMISQWPCNAEDAVASVCEAVDVCF---GD-----DCTMDMQFCET---TDISITTCNAVD-- | | | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | YDEEGGFYTKP--VMVSQWPIQVSDSVDHETVD----- | | | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | YDEEGGNDLNKV--VMISQWSCDGESENEQKEEQQIQ-----NG--S----- | | | | | | | | | | | | |
| <i>CDPHE15</i> | YDDHGGKNSRT--VVVSQWPPADVDESCDDSDDDDDSDH-----EADDE--SS--AEHDDDPESA-- | | | | | | | | | | | | |
| <i>FCoV</i> | YDTCGGFDINPDGMISQYDLNTAADDKSDSDASVEDISLIS-----DNEDV-----EQIEEDNTST--D--DA----- | | | | | | | | | | | | |
| <i>Ferret-CoV</i> | YDSCGGFDVHCPEGIMVSQYDLSVDSNIECVEDACNLE-----YVEEVSD--Y--C----- | | | | | | | | | | | | |
| <i>HKU10</i> | YDEEGGNDFTKV--VMVSQYSIADEQPENVGQTDVVK-----EE--Q----- | | | | | | | | | | | | |
| <i>HKU2</i> | YDEEGGNDLNL--VMISEWPLQVDEVSELVSTDET-- | | | | | | | | | | | | |
| <i>HKU8</i> | YDEEGGTDLSKV--VMVSQWPLKSSPEPQNFDPSPLAAFVVSGLCEDFSGCGDPVSCFQTV-----EGAALCISMERSCKCGTDQAVCEG---FYVPVKCASTDTCDECGC--D--RI----- | | | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | YAV-----LNRGYTVESDDVSFEGGVA-----QYECNISFAKKPFKSLHTKYQHVLPLGMFPCIEGTNGAKLLTDLGLQ-----NLKPGIIGAL--HEAGSYW--CS----- | | | | | | | | | | | | |
| <i>Mink-CoV</i> | YDCAGGFVGCNDGIMISQYDIDVAPLENVEEVSDVE-----VVDDPST--N--D----- | | | | | | | | | | | | |
| <i>NL63</i> | YDEEGGYDVSQP--VMISQWPIISNDSNGCVVEAS----- | | | | | | | | | | | | |
| <i>NL63-related</i> | YDEEGGEDMSKP--VMISQWPIESD--GCEVNDVGE----- | | | | | | | | | | | | |
| <i>Porcine-EDV</i> | YDEEGGTDPNLP--VMVSQWPLNDDTISQDLLDVEVVTD--P--PID-----SEGDEVDS----- | | | | | | | | | | | | |
| <i>TGE</i> | YDTCGGFDIKNPDGIMISQYDINITADEKSEVSASSEEEEVES-----VEEDP-----ENEIVE--AS--E--GA----- | | | | | | | | | | | | |



1660 1670 1680 1690 1700 1710 1720 1730 1740 1750 1760 1770

Bat-BCoV -----VDT-----CAV-----AV-NRDNT-----P-----STQSI-----VTVSPQREVHHY-----
Bovine-CoV -----VEEDVEMSDFADLESVIQDYENVCFEFY---TTEPEFVKVLDLYVPKATRNNCWLRSLAVMQKLPQCFKDKNLQDLWVLYKQQYSQLFVDTLVNKIPANIVVPPGGYVADFAYW-FLT
Covid-19 -----DNQT-----T-----TIQTI-----VEVQFQLEME-----
GCCDC1 -----VSFPV-----VEGIFEA-----
HKU1 D-----IESIYDFDITYKALLVFNVDVNDALFVSYGSSVETETYFKVNGLWSPTITHTNCWLRSLVLLVMQKLPFKFKDLAIENMWLSYKVGYNQSFVDYLLTTPKAIKAVLPPGGYVADFAYW-FLN
HKU14 VV----SADSDSVLVHDYIDGVNYDTFYCDTVDFDYVA-HKEPDFVKVLGVYVPKATRNNCWLRSLAVFQKLPCTFKDKNLQSLWLSYKQDFDQFVDTIMQKIPANIVVPPGGYVADFAYW-LLT
HKU24 -----YQLHGNVCDYVAAYEEAVSDFWT--VQQDEFIHCVGVFVPKTTRTNCWLRSLAVMQKIPCVFKDKKLNLCVYKNQYSSDFVDALLKKIPDNIIVPEGGYVADFAYW-FLT
HKU4 E-----TDD-----VLE-----LETA-----VVGPFVSDVTA-----
HKU5 K-----AND-----CAE-----GMPALDST-----E-----TVSKL-----SVDTPVGDVTDQDDATSSNAT
HKU9 -----TIQ-----
Hedgehog-CoV Q-----QSD-----CVK-----HVVL-----GTTNT-----S---
MERS-CoV I-----AD-----TLQ-----ETPV-----
MHV T-----ELNAPADKTYEDVLAFLAVDVCSEALSAFYAV-PSDETHFKVCGFYSPAERTNCWLRSTLIVMQSLPLEFKDLEMQKLWLSYKAGYDQCFVDKLVKSVPKSIILPQGGYVADFAYF-FLS
OC43 -----VEEDVEMSDFVDLESVIQDYENVCFEFY---TTEPEFVKVGLYVPKATRNNCWLRSLAVMQKLPQCFKDKNLQDLWVLYKQQYSQLFVDTLVNKIPANIVLPPGGYVADFAYW-FLT
Rat-CoV T-----ELNAPADRTYEDVLAFLADAIYSKALSAVYAV-PSDETHFKVCGFYSPAERTNCWLRSTLIVMQSLPLEFKDLEMQKLWLSYKAGYDQCFVDKLVKSVPRSIILPQGGYVADFAYF-FLS
SARS-CoV -----P-----
229E EVNSIF---DIETV---DVK---HEMSP-----F-EMPFEELNGLKILKQLDNNCWVNSVMLQIQLTGILDGDYA----MQFFKMGRVAKMIERCYTAEQCI-RGAMGDVGLCMY----RL
Bat-CoV-1A AVNHALSFMKP--TE---TKF-----VD--P-----F-KFDYDHEGIRVLRQNNNCWVASTLVQLQLSCLLDDDDT---MALFKAGSVSPLVRKCYDAVGAI-VGSLGDASHCLE----VL
BtCoV512 EVQQALAFIE--DK---PVV-----VKPDV-----F-AFSYASYGGLKVLNQSNNCWVSSALVQLQLTGLLD--SDE---MQLFNAGRVSPMVKRCYESQRAI-FGSLGDVSAACLE----SL
BtMr-AlphaCoV EVEEALAYMKPEV-V---KPV---VEKSM-----F-DYPSTVFNGIRVLKQVANNCWLTATYQLQLADCYE-ADD---YSLFKVGSVKHFVKRCYESVGAV-KGSLGDTTQLE----RL
BtNv-AlphaCoV EVREALSFIKEV-EP---QP-----LNP-----F-AFEFTDYCGLKVLKQVNNCWVNASACLHMQLDLL-DTPA---MDLYKCRVGPLVQSCYESVKQL-VGSMGDVTECLE----HM
BtRf-AlphaCoV EVEAALSYM-TPTAP---KPT---EN--P-----F-AFEYDINGIKVLRQDNNCWVASALVQLQLLNVN-EDYT---YFFKSGRLSPLVKRCYERTGNI-RGSAGDTSHCLE----VM
CDPHE15 EVNDALSFMTESSPK---PCE---PTSDT-----F-AYPFKDYNGVKVLDQSSNNCWVNSTLLQLQLLGVIGDDSA---MALFKVGRVGPVVKRCYEAVGAI-KGSLGDVSQCME----VL
FCoV AKNDPWAAAVD---E---QEA-----EQPKP-----SLT-PFKTTNLNGKIILKQDNNCWVNASALVQLQLLNVLN-EDYT---YFFKSGRLSPLVKRCYERTGNI-RGSAGDTSHCLE----VM
Ferret-CoV VDEDCG-----VQTV-----SVF-AFDNSTINGKVVLLKQSQNNCWVNASALVQLQLLNVLN-EDYT---YFFKSGRLSPLVKRCYERTGNI-RGSAGDTSHCLE----VM
HKU10 EVNEALSFMLEPVQQ---KPK---VN--P-----F-NFEFYDYKIRVLKQKDNNCWVSSTLVQLQLLDCY-SDPA---FDLFAKAGSVAPIVQKCYELTRNI-VGSAGDVSFALE----QL
HKU2 EVNKAFAI---DD---SPK---RAISP-----F-GFDTNEINGRRVLYQSNNCWVNAACYQLQVLGF--DSPA---MELYRVGGTHNLVKQCYEATGAF-LGSLGDVAHCLE----VL
HKU8 EVAEALSFIVD--EP---SAF---VD--P-----F-KFEYDHAGVVRVLKQEVNNCWVASTLVQLQLYGF--DSPA---MELYRVGGTHNLVKQCYEATGAF-LGSLGDVAHCLE----VL
LuchengRn-CoV CASKKLSFVLADYDADDFNAH---VAKVH---TKFPVTAIDDRGGYKHLRLRDNNCWANAVFVGLQLCDYYTKDDM--VWQCALRGANSRFLKLYNANKTF-YGSTADAAQALE----RL
Mink-CoV VDDEPI-----TDVM-----SPF-AFPNSMINGKVVLLKQSQNNCWVNASALVQLQLKALE-DES---FKQYACAGDVAPFVQLMYAVTNRN-IGDLGAEAYVLE----QL
NL63 IIEQPF---EEV-E---HVL-----SIKQP-----F-SFSFRDELGVRVLDQSDNNCWISTTLVQLQLTKLLDSSIE---MQLFKVGVKVDIVQKCYELSHLI-SGSLGDSGKLLS----EL
NL63-related QVNKAF---GPVVK---SAP---VPEHP-----F-AFPFRDELGVRVLDQSDNNCWISTTLVQLQLTKLLDSSIE---MQLFKVGVKVDIVQKCYELSHLI-SGSLGDSGKLLS----EL
Porcine-EDV EVAATLSFIK---DT---PST-----VTKDP-----F-AFDFVSYGGLKVLKQSHNNCWVSTLVQLQLLGIVD-DPA---MELFSAGRVGPMVVKRCYESQKAI-LGSLGDVSAACLE----SL
TGE AKDDPWAAAVD---V---OEA-----EOPNP-----SLP-PFKTTNLNGKIILKQDNNCWVNASALVQLQLKALE-DES---FKQYACAGDVAPFVQLMYAVTNRN-IGDLGAEAYVLE----QL



1780 1790 1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900

Bat-CoV VVTEEK---WDEHVCGS-CK---PCEIP-----LSVKAKRVNQNSVNCGEKAVVTVN---STTVF-----NTPVPREVEAK-----TANEQPKVD---S

Bovine-CoV LCDWQCVAWKCICKDLALK---LKGLD----AMFFYGDVVSHVC-KCGESMVLIDVDPFTAHAFFALKDKL-----FCAFITKRSVYKAA-----CVVDVNDSSHMAVVDG---KQID---D

Covid-19 -----L-----TPV-----

GCCDC1 -----

HKU1 QFDINAYANWCCLKGFSFD---LNGLD----ALFFYGDIVSHVC-KCGHNMTLIAADLPCTLHFLSFDN-----FCAFCTPKKIFIAA-----CAVDVNVCHSVAVIGD---EQID---G

HKU14 LCDWNAASHWRCLKCDLALN---LQGLD----AIFFFYGDIVSHVC-KCGESMVLKVDVDPFTAHAFFAVKDKQ-----FCSFTTQRRIFKAA-----CVIDKNDRHSMVAIDG---KQID---D

HKU24 QCKWDANSYWRCLKGIDSE---YKGLD----AMFFYGDVISQPCKKCGQSMVALKLDAPCTLHFLSFDITTT-----FSAFFSLKRVYLA-----CVVDVHNHRSLAVIDYNGLKQVD---G

HKU4 IVTNDIVSVEQAQQCGVSSL---PIQD-----EASENQVHVQVSDLQG-----N---E-----LLCSETKVEI-----VQPR---Q

HKU5 VISEDVH---TATHSKGLVAV---PEVVP-----EKALGTSVERMRSTSE-----WTVVE-----TSLKQETAVI-----VKND---S

HKU9 -----

Hedgehog-CoV EVCVDVE-----HCVVVDQI---SEEVP-----KGAAPPVMEEEKPSQE---V---S-----GSPEP---SLKE-----DKPH---K

MERS-CoV -VPDVE---VPPQVVKLPSA---PQTI-----QPEVK-----E-----VAPVYEADTE-----QTQN---V

MHV QCSFKAYANWRCLCDMELK---LQGLD----AMFFYGDVVSHMC-KCGNSMTLLSADIPYTLHFGVRDDK-----FCAFYTPRKVFRAA-----CAVDVNDCHSMAVVEG---KQID---G

OC43 LCDWQCVAWKCICKDLALK---LKGLD----AMFFYGDVVSHIC-KCGESMVLIDVDPFTAHAFFALKDKL-----FCAFITKRIVYKAA-----CVVDVNDSSHMAVVDG---KQID---D

Rat-CoV QCSFKAHANWRCLKCDMASK---LQGLD----AMFFYGDVVSHMC-KCGSGMTLLSADIPYTLHFGVRDDK-----FCAFYTPRKVFRAA-----CAVDVNDCHSMAVVDG---KLID---G

SARS-CoV -----E-P-----

229E LKDLHTGFMVMDYKCSCTSG---RLEESGAVLFCPTTKKAFPYGTCLNENAPRMCTIRQLQGTIIFVQKPEPV--NPVSFVVKPVCSSIFRGA---VSCGHYQTNIIYSQNLCDVDFGVNKIQPWTN

Bat-CoV-1A LKDLHTMFITCDATCGCGSS---NYELTGSVFRFMPTRDSFSYGACVCGKTLKLRITMTGTGFFCQ--DPKPF--NTARAIKVPVCASIIYQGS---TTSGHYKTNVFGKRFCVDGSGVSSIS---N

BtCoV512 LKDRDMSITCTIDCGCGP---VRVYENAI FRFTPLKTAFFPMGRCLICSKTLMHTITQMKGTGIFCR-DATAL--DVDTLVVKPLCAAVYVGA---QDGGHYLTNMYDANMAVDGHRHPK---F

BtMr-AlphaCoV CKDVKTLKVTNCVACDCGTS---VKVLEGCVFHFMVADAFPYGVCSNCKQVAMHTIMGINGTGFFCQ-EPAHF--DVKKALCSIAATATYVVG---QNGGHYRTNDFVHGKAVDGSGITPLN---Y

BtNv-AlphaCoV LKDKVSCVVDCAVDCGTK---DLTIEGCVFRFMPCEPLE--RWCVCNSMAACTIKGKGTAFICQ-KPGPA--N--DLYVEPYCAASFIGS---VTSGHYRTNVTYHTGKAVDGFVGHID---N

BtRf-AlphaCoV LRDHLTMQLRFSVKCKCGTF---TEEMSGCVFRFMP TAKAFPYGGCASC GKTKMYTITTMKGTGVFCQ-EPNPL--NISDLLVEPLCASVFK-----SGHYKTNIIYKYNVCDVGNRGOIK---W

CDPHE15 LRDVKTTLTVHCDTVDCGSG---AKTFVGCFAFRFEPTEPFYGCCQNKQVLLHTITTSISGTGVFCR-EPTPF--DISVMPPIRPLCAANYVGA---VDGGHYMTNIIYTNNAVDGHHVHVA---N

FCoV LNDYSTAKVTL SAKCGCVK---EIVLERTVFKLTPLRNEFKYGVCGDKQINMCKFASVEGSGVFVH-DRIEKQTPVSQFIVTPTMHAVYTG---TQSGHYMIEDCIHDYCVDMGKIKPRK---H

Ferret-CoV LGGLETAKVTL SAQCDCGIV---EDVIAGCAFRMCCD TDFDYGMCGTCRVIKKTITIVKVEGTGVFLH-EPKTY-----KPLVKPVCKAIFKGD---TDGGHYMVHDVEAKVLDVDFGLHPVK---N

HKU10 LKDLHTMFITFDVVCNNGERRQSELSGCVFRFLPTSEPFAYGGCPSCKPLMHTITSMQGTGVFCQ-DPKAV--DVTLLVQPMCASAFIGNWFNNSLGHYKTNVYDKGFCVDGNGSWPIT---L

HKU2 LKDAKTAKVTVEVTCDCSSN---FEELSGAFFRFLRLRSKFYEGSCFACHGTRYRVCVGVSAIFSQ-TLKPL--DFNDLICDVASAVFLGD---DCGHYLINDYDKRLCVDGMGVYKIR---H

HKU8 LSDSHTMFMTFDVCKDCGAS---VAEMSGAVFRFMPTRDSFNYGACPTCRSVMVYKIKSMQGTGVFCQ-DPKPF--NTARSLVRPVSASVYSGR---TDGGHYKTNIIYDARVCDVDFGVTSIT---T

LuchengRn-CoV LDGDACMTVKLALSFCGDS---TVELRSSVLKFRP INGFFDYGYCNVCE TTIQALILHVEGKGFICYATKD---SKMLFPGCVGEIVYTGP---DQGGHYIYKYGG---GYHDTGSRRSA---

Mink-CoV LSSAQTAKVKLSALCSCGTM---EELISGCVFRMRC T SATFDYGVCGVCKTVKKTITIVGIEGTGVFVH-DPANY-----KPLVKPVCKAIFKGS---TTGGHYMVHDVLA KVLVDVDFGLHPVQ---N

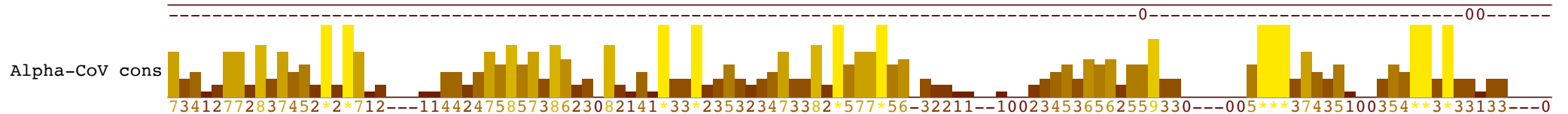
NL63 LKEKYTC SIFTEMSCDCGKK---FDDQVGLFWIMPYTKLFQKGECCICHKMQTYKLVSMKGTGVFCQ-DPAPI--DIDAFPVKPICSSVYLGV---KSGHYQTNLYSFNKAIDGFGVFDIK---N

NL63-related LKDKFTCFMTFETLCGCGKR---RDEQAGCWFWIMPYTKFPYKCSICRKTQIYKLTSMKGTGVFCQ-DPAPV--DFDALPTMPCASAYLGS---RSGHYQTNLYNVNKAIDGFGVSDIK---N

Porcine-EDV TKDLHTLKITCSVVC GGTG---ERIEYEGCAFRMPTLEPFYGACQAQVLMHTFKSIVGTGIFCR-DTTAL--SLDSLIVVKPLCAAFIGK---DSGHYVTNFYDAAMAIDGYGRH QIK---Y

TGE LNDYSTAKIVLAAKCGCEK---EIVLERAVFKLTPLKESFNYGVC GDCMOVNTRFLSVEGSGVFVH-DILSKOTPEAMFVVKPVMHAVYTG---TONGHYMVDDIEHGVCVDGMGKIKPLK---K

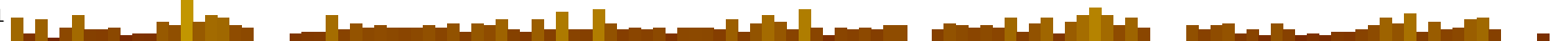
Beta-CoV cons

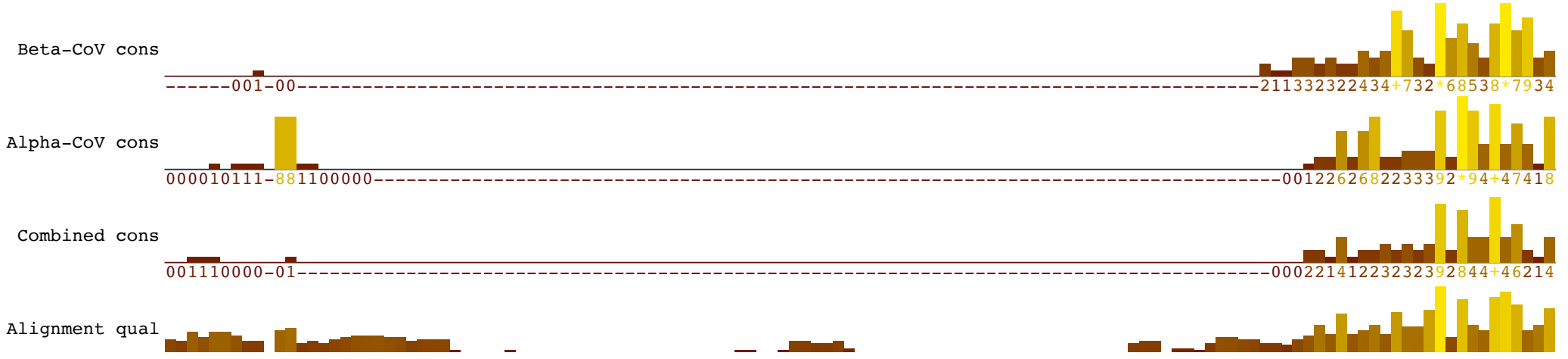
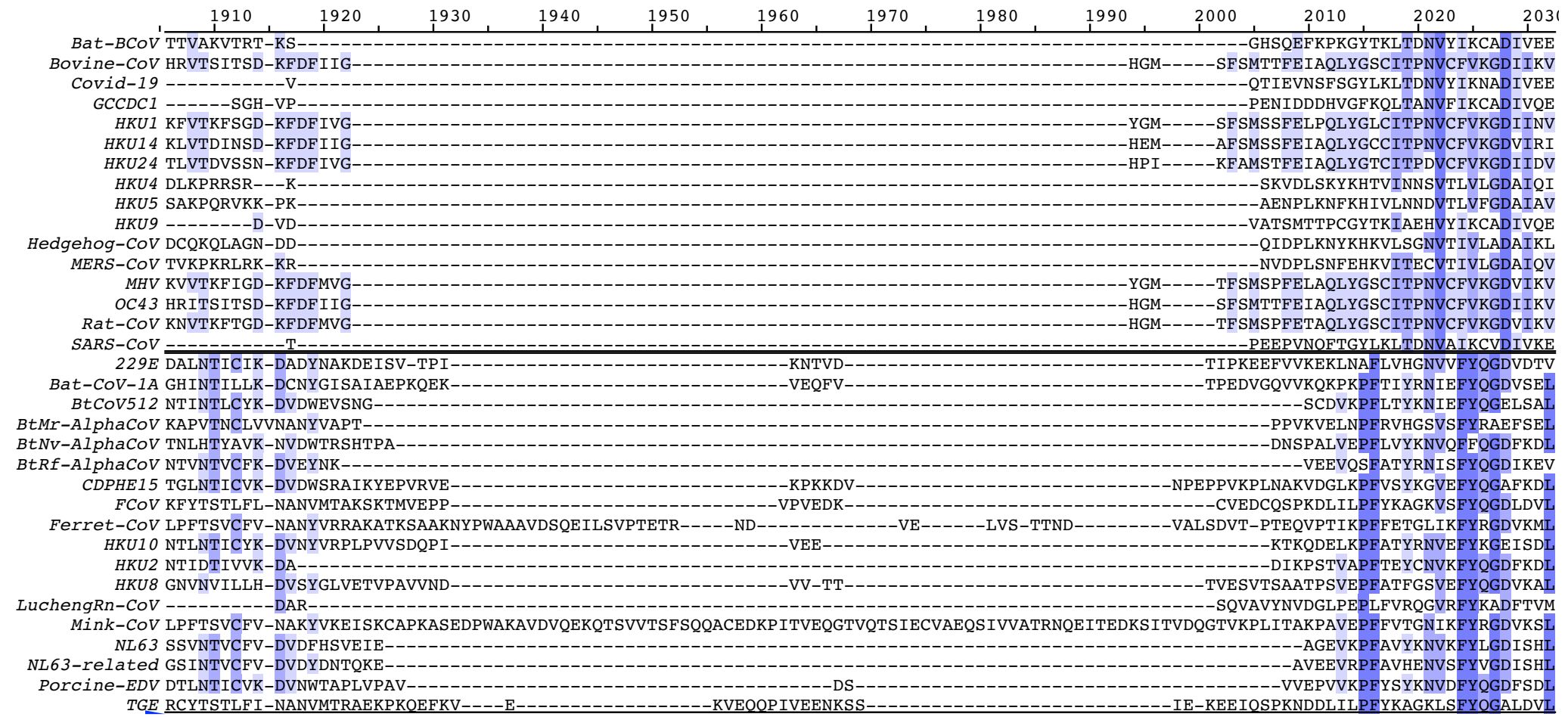


Combined cons

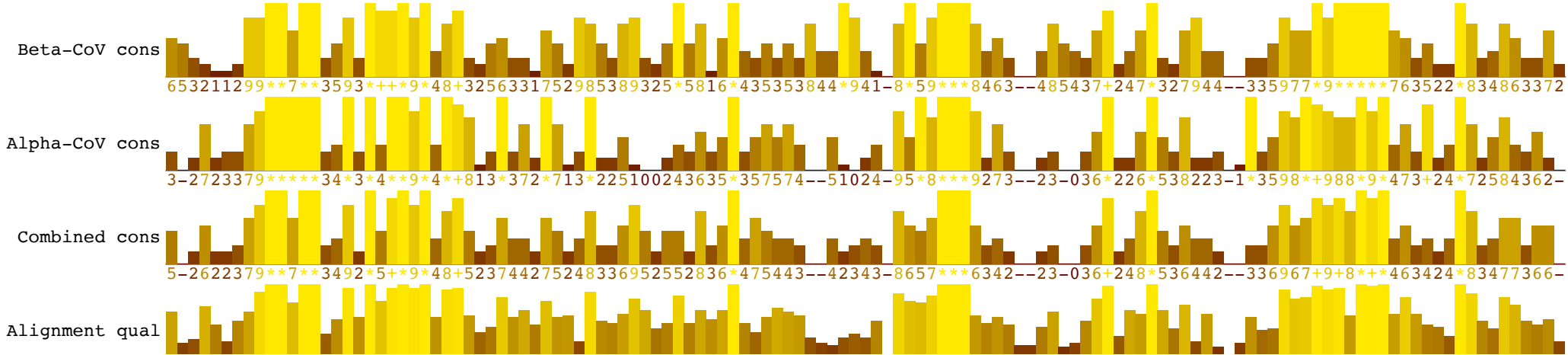


Alignment qual





Bat-BCoV ARNTKPPILVNAANCKLKHGGGVAGAIRKAVGNSIQEDSDLYIKENGAIPVGGAAALLPGYNLATN-ILHVVGPNTIM--NEDSSLIVNAYSNLNSF--STVVTPLLSAGIFGMPKPIDSLTALLSTCK
Bovine-CoV SKRVKAEVVVNPANGHMAHGGGVAKAIAVAAGQQFVKETTDMVSKSGVCATGDCYVSTGGKLGKCT-VLNVVGPDPARTQKGQSYALLERVYKHLNKY--DCVVTTLLSAGIFSVPSDVSILTYLLGTAE
Covid-19 AKVKPTVVVNAANVYLKHGGGVAGALNKATNNAMQVESDDYIATNGLPKVGGSCVLSGHNLAKH-CLHVVGPNVNK--GEDIQLLSAYENFNQH--EVLLAPLLSAGIFGADPIHSLRVCDTVR
GCCDC1 ATSRSYKVLVNAANVNLHGGGVAGALNRASDNAMQAESTAYIREHGPLQPNGVLLSGLHGLAQDGIILHVVGPDKRL--QQLDLTLGQVYQLYNAH--DDILTPPLVSAGIFGFTVEESLVCRCNVVT
HKU1 ARLVKADVIVNPANGHMLHGGGVAKAIAVAAGKFKSKETAAMVSKSGVCQVGDYVSTGGKLGKCT-ILNIVGPDARQDGRQSYVLLARAYKHLNLY--DCCLSTLLSAGIFSVPADVSLTYLLGVVD
HKU14 AQLVYADVIVNPANGHMAHGGGVAKAIAVAAGQSFIKETANMVSKSGVCATGDCYVSSGGKLGKCT-VLNVVGPDPARAQKQCYALLEKTYKHLNKY--DCSLTLLSAGIFSVPSDVSILTYLLGVVE
HKU24 SKKVADVVVNPANSHMAHGGGVAKAIAVAAGDAFNKETSMDVKLRGPCVGECKSTGGKLGKCL-VLNVVGPDPARAQKQSYALLERVYKAFNKY--ECCVTTLLSAGIFSVPSDVSILTYLLGATT
HKU4 ASLLPKCILVNAANRHLKHGGGIAGVINKASGGDVEEESDEYISNNGPLHVGDSVLLKHGLADA-ILHVVGPDPARN--NEDAALLKRCYKAFNKH--TIVVTPPLSAGIFSVDPKVSFEYLLANVT
HKU5 ARATEDCILVNAANTHLKHGGGIAAIDRASGGLVQAESDDYVNFYGPLNVGDSTLLKHGLATG-ILHVVGPDPARA--NQDIQLLKRCYKAFNKY--PLVVSPLSAGIFCVEPRVSELYLLSVVH
HKU9 ARNYSYAVLVNAANVNLHGGGVAGALNRATNNAMQESSEYIKANGSLQPGGHVLLSSHGLASHGILHVVGPDKRL--QQDLALLDAVYAAYTG--DSVLTPLVSAGIFGFTVEESLCSLVKNVA
Hedgehog-CoV ARCFSSSVLVNAANSHLKHAGGIAHAIDSASKAVQRESDDYIKNNGALQVGDVTLVLLKHGLAKH-ILHVVGPDPARQ--QQDVTLSSKCYKAMNAH--PLVVTPPLVSAGIFGVDPKVSLQMLQOVAK
MERS-CoV AKCYGESVLVNAANTHLKHGGGIAGAINAASKGAVQKESDEYILAKGPLQVGDVLLQGHSLAKN-ILHVVGPDPARA--KQDVSLSSKCYKAMNAY--PLVVTPPLVSAGIFGVKPAVSDYLI IREAK
MHV VRLVNAEVIIVNPANGRMAHAGGAVAGIAEAKAGSAFIKETSMDMVKAQVCVQVGECEYASAGGKLGKCK-VLNVVGPDPARGHGKQCYSLLERAYQHINKC--DNVVTLLSAGIFSVPTDVSILTYLLGVVT
OC43 SKLVKAEVVVNPANGHMAHGGGVAKAIAVAAGQQFVKETTDMVSKSGVCATGDCYVSTGGKLGKCT-VLNVVGPDPARTQKGQSYVLLERVYKHLNLY--DCVVTTLLSAGIFSVPSDVSILTYLLGTAK
Rat-CoV ARLVEAEVIIVNPANGRMAHAGGAVAGIAKAGKFVKETADVMKNGVCLVGECEYASAGGKLCKK-ILNIVGPDARGQGRQCYSLLERAYQHINKC--DNVVTLLSAGIFSVPTDVSILTYLLGVVT
SARS-CoV AOSANPMVIIVNAANTHLKHGGGVAGALNKATNGAMOKESDDYIKLNGPLTVGGSCVLSGHNLAKK-CLHVVGPNTLNA--GEDIQLLKAAYENFNQ--DILLAPLLSAGIFGAKPLOSLOVCVOTVR
229E VNGVDFDFIVNAANENLAHGGGLAKALDVYTKGKLQRLSKEHIGLAGKRVGTGMVVE--CDSLRFNIVVGPGRKG--HE-RDLLVKAYNTINNE-QGTPPLTPILSCGIFGVKLETSLEVLLDVC-
Bat-CoV-1A V-GLDFDFIVNAANENLKHAGGVAAAIDKLTGNELOSLSNKYVKTNKGVKVGSSAMIR--CKKYS-VLNVVGPGRKG--HA-PDLEKCYRILTKE-QGVPLTPPLISVGI FGIPLATSFNALLNDS-
BtCoV512 L-SVNHDFFVNAANEQLSHGGGIAKALDDLTGKGLQVLSNQYVSRNGSIVKVGSGVLIK--CKEHS-ILNVVGPGRKG--HA-AELLTKAYTFVFKQ-KGVPLMPLLSVGIFKVPITESLAFLACV-
BtMr-AlphaCoV V-NLDYDFVNAANENLSHGGGVAKAIDDYTKGQLQLLSKAYVKSHGRVRTGNAMIK--CDSFD-VLNVVGPGRKG--KSWQKLLRFAYETIYKQ-GTTPPLPPLSCGIFGVPLEESLKMLLDTC-
BtNv-AlphaCoV VGGVQHDFFVNAANERLQHG GGVAKAIDHHTGKGLQRLSSAHVKKHGKVSVGSGVMLE--CSGVK-VLNVVGPGRHGA--GE-VALLEAYNICIFDQ-DGVPLTPPLIGVIFKVPITTSKALDDVV-
BtRf-AlphaCoV K-SVNHDFFIVNAANEDLHGGGIAGALNKYTKGVLQKVSNAHITANGKLVKVGSGVME--CDGTN-IFNVVGPGRKG--HA-PELLIKAYDAIFSN-PGVPLTPPLISVGI FKVPIEDSLSALFASA-
CDPHE15 L-DLPPDFVNAANEQLSHGGGVARAIDEHTGGELQSLSDRYVKAVGPKVGTGAYIK--CKAFD-VFNVVGPGRKG--HA-KDLLVKSYSVSV-PGVPLMPLLSIGIFRVPIDSLSALFACV-
FCoV INFLEPDVLVNAANGDLRHVGGVARAIDVFTGGKTKRSKEYLSSKAIPGNAVLFENVLEHLS-VLNAVGPGRNGD--SRVEGKLCNVYKAIKAC-DGKILTPLISVGI FVKLEVSLQCLLKTIV-
Ferret-CoV VGAIKPKVLVNAANPHLQHKGGVAKAIDDFTAGALSLESTNYLKHYPKIPSGNVVVFNDVFAGLN-IANAVGPRVSE--ERYEQKLASVYRKLAKV-EGPMLTPLISCGIFGVPLEQLSALIKAF-
HKU10 V-QLKHDFVNAANENLSHGGGVAAAINNLTGKLLQTLSDHYVKKNGKIKVGGVMLH--CGKEN-VLNVVGPGRKG--HS-PQLEKAYKFVLKQ-KGTTPPLPPLSVGI FKVPIESVTKLKNV-
HKU2 A-GLSHDFVNAANENLAHGGGVAKAIDHHTGKGLQRLSSTFVKKNGKVATGECVMD--TGKLV-VLNAVGPGRKG--DA-ESLLNTVTYTNIFAR-KGVPLMPLISCGIFGFDLKDSLRAFLAAC-
HKU8 S-ALPCDFVNAANENLQHAGGVAKAINDLTGGVQRLSDDYTRANGKVKVGCGVME--CP-LR-VFNVVGPGRKG--HA-RSLLVKCYKSVLSN-PGVPLTPPLSVGI FGVPLSDSFIALTSV-
LuchengRn-CoV L-KFKPACVVNAANENLSHGGGIARAINQATNGELQKLSDRC---RNPKVGSCTAVK--CRNFE-VLNAVGPGRD--TNVDGLLRSAVDSVRKQGHGLVVTPLLSVGI FNVPIATSLAQFLDAFD-
Mink-CoV VENLKPVLVNAANSHLQHKGGVAKAIDAYTNGALTRSEVYFKQYKPIPPGNIIVFNDVVKGLN-IANAVGPRVSE--ERCAQKLDVYRKMTKI-EGPILTPLISCGIFGVPLEQLSLRLAAAF-
NL63 VNCVSDFVNAANENLHGGGVARAIIDILTEGQLQSLSKDYISSNGLPKVAGVME--CEKFN-VFNVVGPRTGK--HE-HSLLVEAYNSILFE-NGIPLMPLLSVGI FGVRIENSLKALFSCD-
NL63-related IDSVPDFVNAANENLAHGGGVARAIIDLTGKQLQSLSNAYIRNKGLPKVGTGMVKL--CNKFS-VYVNVGPGRKG--HE-HTLLVKAYNSILAE-EGTPMLPILSCGIFGVKLENSLKFSCN-
Porcine-EDV V-KLPCDFVNAANEKLSHGGGIAKAIDVYTKGMLQKCSNDYIKAHGPIKVGRVME--ALGLK-VFNVVGPGRKG--HA-PELLIKAYKSVFAN-SGVALTPPLISVGI FSVPLEESLSAFLACV-
TGE INFLEPDVIIVNAANGDLKHMGGVARAIDVFTGGKLTERRSDYLLKKNKSIAPGNAVFFENVIEHLS-VLNAVGPGRNGD--SRVEAKLCNVYKAIKAC-EGKILTPLISVGI FNVRLTSLQCLLKTIV-



| | 2170 | 2180 | 2190 | 2200 | 2210 | 2220 | 2230 | 2240 | 2250 | 2260 | 2270 | 2280 |
|----------------------|-----------------|-------------|-----------------|-----------------|-------------|-------------|---------|------------|-----------|------------|------------|-----------|
| <i>Bat-CoV</i> | KTV--YVVVNDKTI | FDACCSHINN | KDV----- | ----- | KTPSKPV-- | YMM----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Bovine-CoV</i> | KQV--VLVSNNQED | FDLISKCQITA | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Covid-19</i> | TNV--YLAVFDKNLY | DKLVSSFLEMK | SEKQVEQKIAE | IPKKEEVKPF | ITESKPS-- | VEQRKQDDKKI | KACV-- | EEVTTTLEET | KFLTENLLY | IDI-- | NGNLHPDSAT | LVSDI-- |
| <i>GCCDC1</i> | ANT--FIVVYDKQL | YSRACAVSRQD | LEPAPLARKEA | CVVAVSN-- | DAQQESQEND | WAAAVEFQEK | NHNVE-- | EVVGGPYPSG | DAPVPPAAL | VDAKTTTE-- | ----- | APCEDASIT |
| <i>HKU1</i> | KQV--ILVSNNKED | FDIIQKCQITS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU14</i> | KQV--ILVSNNKED | FDLISKQLTA | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU24</i> | KKV--VLVSNNKED | FKLIEGCQTTA | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU4</i> | TTT--YVVVNNE | IYNTLATPSK | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU5</i> | TKT--YVVVNSEK | VYNDLAAPKP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU9</i> | CTT--YVVVYDRQ | LERALATSF | DVPGPQ-- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Hedgehog-CoV</i> | TRV--LVCVNSAN | IEALTEVVV | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>MERS-CoV</i> | TRV--LVVVNSQD | VYKSLTIVDI | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>MHV</i> | KNV--ILVSNNQDD | FDVIEKCQVTS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>OC43</i> | KQV--VLVSNNQED | FDLISKCQITA | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Rat-CoV</i> | KNV--ILVSNNKDD | FDVIEKCQVTS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>SARS-CoV</i> | TOV--YIAVNDKAL | YEOVMDYLDN | LKPRVEAPKOE | FPNTE-- | DSKTEEKSV-- | VOKPVDVKPKI | KACI-- | DEVTTLLEET | KFLTNKLL | LLFADI-- | NGKLYHDSO | NMLRGE-- |
| <i>229E</i> | NTKEVKVFVYTD | TEVCKVKDFV | SGL--VNVQKVA | QPKI----- | EQ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Bat-CoV-1A</i> | SGRTVRCFCYTD | KECNEIKTLV | ASL--NEEQVAAT | VEE----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtCoV512</i> | GDRVCKCFCYTD | KERLAIQNFV | TSF--QT---EQPVE | ----- | PL----- | P----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtMr-AlphaCoV</i> | NDVRTCCFVYTP | DDEAKVVAYL | DSL--KVQDE | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtNv-AlphaCoV</i> | GDRQCRCFCYSD | SEVAIVAYV | NNM--SAVDDV | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtRf-AlphaCoV</i> | GERVVKCFCYT | SAEKSAIKYI | DSV--TN----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>CDPHE15</i> | GDRVCKCFCYL | DAERDAIQY | VAGL--SVVNE | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>FCoV</i> | TDRDLNVFVYTD | QERVTIENF | NGT--I----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Ferret-CoV</i> | KSISVSFVYTEE | EQRKVLQYF | ETP--V----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU10</i> | GDRHVKCFCY | SVAEVSEIQ | CLDND--VVEPKM | --EV----- | PQ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU2</i> | GDRHVKCFVY | SDSERESVM | KFLMTP--FEENAAT | KE----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU8</i> | GERRVLCFCY | SDTERKAIL | KLIEQR--SS----- | ----- | VDQ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>LuchengRn-CoV</i> | GFTNFYCYVY | TDAEAAAAL | QYFENL--NSLTFEA | AVSS----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Mink-CoV</i> | KQKPICVFVY | TEAERKVL | DYFKTP--V----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>NL63</i> | INKPLQVFVY | SSNEEQAVL | KFLDGL--DLTPV | IDDV--D----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>NL63-related</i> | IDKQLRVFVY | SSKEEAVK | GFLGSL--SVAPV | VREE--K----- | IV----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Porcine-EDV</i> | GDRHCKCFCY | GDKEREAI | IKYMDGL--VDAIF | KEALVD--TT----- | P----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>TGE</i> | NDRGLNVFVY | TDOEROTI | ENFFSCS--I----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |



| | 2290 | 2300 | 2310 | 2320 | 2330 | 2340 | 2350 | 2360 | 2370 | 2380 | 2390 | 2400 | 2410 |
|----------------------|------------------------------------|-------------------------------------|---------------------|--|------------------------|-------------------|--------------------|-----------------|----------------------|--------------------|---------------|------------|-------------|
| <i>Bat-BCoV</i> | DCHKVDDVYVLCIPDRRKGQDLTG | -FKGLKQLKKVTAASCLPGQGKFGFTI | QDVTPLMTACPDIIYL | -VKTSVDNDVQLLCPTVTYINVKQMLARAKQEKLLMCVNI | DNKSFTRNVVHLAKNFQHKPGC | | | | | | | | |
| <i>Bovine-CoV</i> | | | | | | | | | NVGRSIVY | | ETDANKLILS | | NDVA |
| <i>Covid-19</i> | DVVQEGVLTAVVPIPTKKAGGTTEMLAKALRKVP | TDNYITTPYGGQGLNGYTVVEEAKTVLKKCKSAFY | IILPSIISNEKQEI | LGTVSWNLREMLAHAEE | TRKLMPCVETKAI | VSTIQRKYKGIKIQEGV | | | | | | | |
| <i>GCCDC1</i> | NVE-EEVAACMR | | FLLRRVTKSLKSERRETTN | | AAKVTEVVQEAPAE | | | PVVASSQSHLKDVL | CMSFSQMIQYAKSHGLLTPV | VLDYTA | FSKVL | | RKYEPKSGL |
| <i>HKU1</i> | | | | | | | | | NVGRVIKF | | ETDAYKFLS | | GDDC |
| <i>HKU14</i> | | | | | | | | | NVGRTIKY | | ETDANKLLIS | | NDVV |
| <i>HKU24</i> | | | | | | | | | QLGRQIKY | | EIDTIAL | LD | KETT |
| <i>HKU4</i> | | | | E | | | | | GWRGTVRTAKNYGFTCF | ICTEYSANVKFLR | | | TKGVDTTKKI |
| <i>HKU5</i> | | | | E | | | | | GWRGIIRNAKSF | GFTCFICTDQSANAKLLK | | | GRGVDLTKKT |
| <i>HKU9</i> | DVV-ADVESCVR | | DLVRQVVKVVRDKRPPPI | | VPQ | QTVEQQPQEI | | SSPGDCNTVLVDVVS | MFSAMVNF | GKEKGLLIPVVIDYPA | FLKVL | | KRFSPKEGL |
| <i>Hedgehog-CoV</i> | | | E | | | | | | | GMKSAVAKAKEYGFTMF | ICVDNKQNVKLLK | | TLGVKADKKQ |
| <i>MERS-CoV</i> | | | D | | | | | | | GLRGAIRKAKDYGFTV | FVCTDNSANTKVL | | NKGVDTYTKKF |
| <i>MHV</i> | | | | | | | | | | NLCRDVKF | | VTNACSSL | F |
| <i>OC43</i> | | | | | | | | | | NVGRSIVY | | ETDANKLILI | NDVA |
| <i>Rat-CoV</i> | | | | | | | | | | NLCRDVKF | | ETNACDTL | F |
| <i>SARS-CoV</i> | DVITSGDITCVVIPS | KKAGGTTEMLSRALKV | VPVDEYITTPYGGQ | CAGYTL | EEAKTALKKCKSAFY | VLPSEAPNAKEE | ILGTVSWNLREMLAHAEE | TRKLMPCMDVRA | IMATI | ORKYKGIKIOEGI | | | |
| <i>229E</i> | VSLIKVAPKPYRVDG | | | | | | | KFSYFTEDL | | LCV | ADDKPIV | LFT | |
| <i>Bat-CoV-1A</i> | VI | VEVNEPVLKVA | | | | | | GVSYYNIED | | SFA | VGADNIV | ILT | |
| <i>BtCoV512</i> | DVKVENPCEPFRIEG | | | | | | | DAKFYDLTP | | SMVQSLQV | TRLVSFT | | |
| <i>BtMr-AlphaCoV</i> | VPAKIEVQPYRVEG | | | | | | | KFNFYDCSV | | ADILATDVSS | VVVFT | | |
| <i>BtNv-AlphaCoV</i> | LPVCPPLTPCRVEG | | | | | | | DVSFYMGSV | | DVLLQSFDR | FVFFV | | |
| <i>BtRf-AlphaCoV</i> | E | VKQILPFRKEG | | | | | | KDFDYEIEA | | ADLALLNP | DRLVIFT | | |
| <i>CDPHE15</i> | EVKQETAFTPRRMEG | | | | | | | SCNFYDCNP | | KALVDNGV | TRFVVFT | | |
| <i>FCoV</i> | | | | | | | | | | | | | |
| <i>Ferret-CoV</i> | | | | | | | | | | | | | |
| <i>HKU10</i> | D | RRELKPCRVEG | | | | | | KFSFYDCPI | | ADIAITEPER | VVFFFT | | |
| <i>HKU2</i> | VEITTDVVAPFYTIG | | | | | | | SHKFYDCNS | | VEPILGLG | VKNIVLFT | | |
| <i>HKU8</i> | IATQPCVPEALEVVG | | | | | | | SVTYYPVDV | | GVVG | VRPNIILHT | | |
| <i>LuchengRn-CoV</i> | GDVEPTQITE | | | | | | | | | | | | |
| <i>Mink-CoV</i> | | | | | | | | | | | | | |
| <i>NL63</i> | VVKPFRVEG | | | | | | | NFSFFDCGV | | NAL | D | GDIYLLFT | |
| <i>NL63-related</i> | VKLKSEDLKPFRC | EG | | | | | | NFSFFDASV | | ESL | S | GDTYLLFT | |
| <i>Porcine-EDV</i> | KPVLPNFEPFRIEG | | | | | | | AHAFYECNP | | EGLMSLGADK | LVLFT | | |
| <i>TGE</i> | | | | | | | | | | | | | |



2420 2430 2440 2450 2460 2470 2480 2490 2500 2510 2520 2530

Bat-BCoV QTVDGYEFYCYTEKQPLSSIIIDELNALGKD-IITTPILGCITHQLSLPESAAMRALKCK-----FLAVCTSPGAEKQFCAAF TAASS--STEEELFMADCVSNGSYMDWIVINKADGDT-I---

Bovine-CoV -----FVSTF-----NVLQDVLS-----LRHDIALLDDAR-----TFVQSN-VDVVPEGWRVVKFYQINGVRTV

Covid-19 -VDYGARFYFYTSKTTVASLINTLNDLNET-LVTMPLGYVTHGLNLEEAARYMRSLKVP-----ATVSVSSPDAVTAYNGY-LTSSS--KTPEEHFIETISLAGSYKDWYSYGQSTQLG-I---

GCCDC1 YEFGGQKFYGYSRPTLEDVSKALNELGLP-LIMIPFGYIVNGAQLSLSAINMRMLQVE-----HTVVLPSESCVPLRYNYVSGITQETTALQDFVVDIIVNGA-KGWDVVQTVCKVDGVITYK

HKU1 -----FVSNS-----SVIQEVL-----LRHDIQLNNDVR-----DYLLSK-MTSLPKDWRLINKFDVINGVKTV

HKU14 -----FVSTF-----NVLQDVNT-----LRHDIKLDDAR-----VFVQSN-MENLPTDWRIVKNKFDQINGVRTV

HKU24 -----LVSTY-----DKLQDIYC-----MQHDIKLDDAR-----AYVQSM-YQSLPEDWRSVFKFVDCAGVRV

HKU4 QTVDGVSYYLYSARDALTDVIAAANG-CSG-ICAMPFGYVTHGLDLAQSGNYVRQVKVP-----YVCLLASKEQIPIMNSD-----VAIQTPETAFINNVTSNGGYHSWHLVSGDLIVKDVCIK

HKU5 QTVDGVKYYLYSSKDPLTDIITAANA-CKG-ICAMPIGYVTHGLDLAQAGQQVKITVP-----YVCLLASKDQVPIINSD-----VAVQTPEQSFINTVIANGGYHCWHLVTGELIVKGVSYR

HKU9 FSSNGYEFYGYSRDKPLHEVSKDLNSLGRP-LIMIPFGYIVNGQTLAVSAVSMRGLTVP-----HTVVVPSSESVPLRYAYFNGVFGDITAVQDFVVDILLNGA-RDWDLVLTCTVDRKVIK

Hedgehog-CoV STVNGVRYCYTSEDTPNLAVANK-QKG-IVALPLGYVTHGFDMQAAAIKVMVTVP-----YVCLLANKEQLAILQGD-----VLKSTPFEEFVTGK-KNGYAHWQLVQGEILVNGVSY

MERS-CoV LTVDGVQYYCYTSDTLDDILQANK-SVG-IISMPFGYVSHGLDLAQAGSVVRRVNP-----YVCLLANKEQEAAILMSE-----DVKLNPSDFIKHVRTNGGYNSWHLVEGELLVQDLRLN

MHV -----FVSSY-----DVLQEVEA-----LRHDIQLDDAR-----VFVQAN-MDCLPTDWRLVKNKFDSDVGVRTI

OC43 -----FVSTF-----NVLQDVLS-----LRHDIALLDDAR-----TFVQSN-VDVVPEGWRVVKFYQINGVRTV

Rat-CoV -----FVASY-----DVLQEVEL-----LRHDIQLDDAR-----VFVQAN-MDCLPTDWRLVKNKLDVVDGVRTI

SARS-CoV -VDYGVRRFFYTSKEPVASIIITKLSLNEP-LVTMPIGYVTHGFNLEEAARCMRSLKAP-----AVVSVSSPDAVTTYNGY-LTSSS--KTSEEHFVETVSLAGSYRDSYSGORTELG-V---

229E -----DSMTLDDRGLALDNLASGVLAAIKDCV--DINKAIPSGNLIKFDI--D-SVVVYMCVVPSEKDK-----HLDNNV-----QRCTR

Bat-CoV-1A -----NSKLELGKIGECIDKHSAGLKLAVSEYL--SQTPNVPPGNVISMRC--SGLATVVFVAVVPSGDV-----QYVRNV-----KRTIS

BtCoV512 -----NSDLCLGSFVRDCGYVQGSLLGGAIANYK--KSNPVLPAAGNCVTLKC--DGFISFTFVILPKEGDT-----NYEKNF-----NRAIA

BtMr-AlphaCoV -----DGKLSLTDVGVEIDEHLSGKLLTSIKECL--AENIAPSGNAMKFDK--NP--TIYMAVVPAINPT-----GFEKNV-----TRTLR

BtNv-AlphaCoV -----SEDLQLCVLASALDVYVYLN--CVTEAL--NKSGLPAGNIVSYKHPKGDGFVVVTFVAVLPAVGSK-----DFDKNV-----KRVFN

BtRf-AlphaCoV -----DTDFKLCDFAIAFNSVVEGGLTSCIEAYR--KENNVVPAGNIVTFKC--EGMVAVSFAVLPVIAAGAA-----SYDKNV-----TRTIN

CDPHE15 -----KPSLDFCDTTKVLDTYFKSLLTNLVKDYVSTLKGKVVPAAGNCVTLRC--TDSVSVTFVVLPTDDDP-----NFETNA-----KRAFQ

FCoV -----

Ferret-CoV -----

HKU10 -----DVKLSFCEAAKALDKHYEGALTSVQAYL--AETPLIPAGNLLTLKC--EGAIPVSFAVLPDPTDAA-----NYNKDV-----KRTL

HKU2 -----DQVLSVKDFGVVVDKHLNGLLSDMSNKYV--GDHKAVFFGNILSLDC--GAFTVVDV-VSPFDGA-----SFEKQS-----GRTIR

HKU8 -----TQDLGLCAFGLLDEQACGALSASIDAYK--QNTAVVPPGNIVTFKC--EGQPTVVLAVFPADDA-----AYLKNV-----KRAVS

LuchengRn-CoV -----DVTVTFGT--DTS-----SI-----

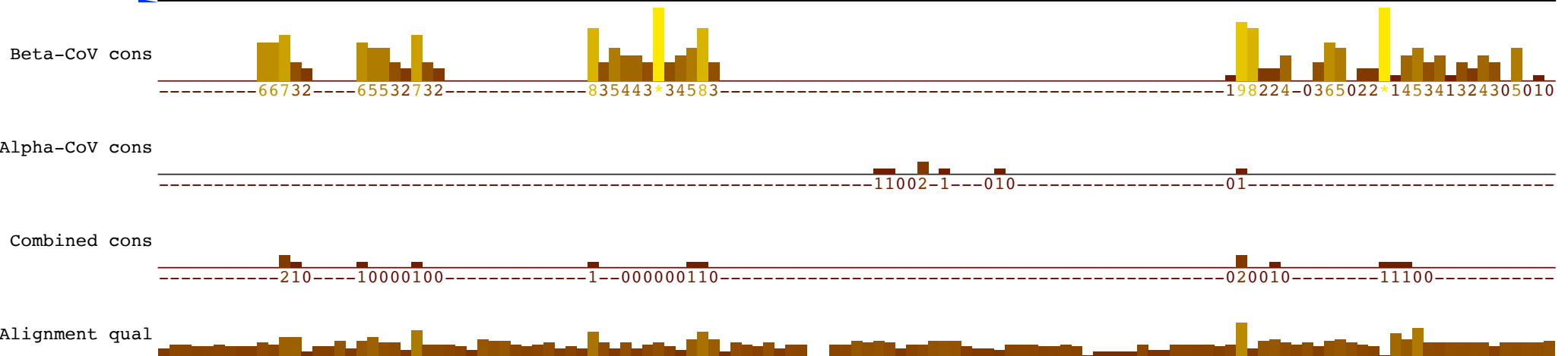
Mink-CoV -----

NL63 -----NSILMLDKQGQLLTKLNGILQQAALDYL--ATVKTVPAGNLVCLFV--E-SCTIYMCVVPSINDL-----SFDKNL-----GRCVR

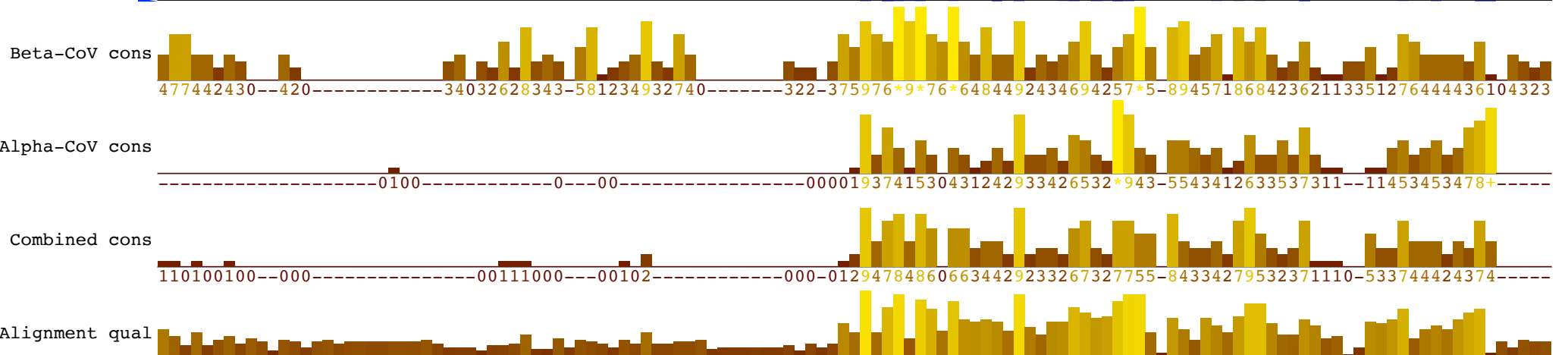
NL63-related -----NSILMLDKQGQLLTKLNGILQQAALDYL--KKVKAVPAGNLVCLV--E-GFTIYMCVVPSAKDP-----SFDKNL-----DRCVR

Porcine-EDV -----NSNLDFCSVGKCLNDVTS GALLEAINVFK--KSNKTVPAAGNCVTLDC--ANMISITMVVLPFDGDA-----NYDKNY-----ARAVV

TGE -----



| | 2550 | 2560 | 2570 | 2580 | 2590 | 2600 | 2610 | 2620 | 2630 | 2640 | 2650 | 2660 |
|----------------------|--------------------------------|-------------------------|----------------------|-----------------|---------------|--------------|---------------|---------------|------------|------------|-------------|--------|
| <i>Bat-BCoV</i> | HFLQRDEDIIDYHT | ----- | ST-NKFSMSGVSGLVFKDV | KILKRYLEKTKPMLK | -EVTVYTTVDG | TNVNTKILICS | SFSFGS | QLGT-CYIDGEDV | TSVFPTKQHE | GKIVNITQV | DDV-TSSQ | |
| <i>Bovine-CoV</i> | KYFECPGGI-DICS | ----- | QDKVFGYVQQG-SFNKATVA | QIKA----- | LFLDKVDILL | TVDGVNFTNRFV | VPVGESFGKSLGN | -VFCDGVNVT | KKHKCDIN | YKGVVFFQ | FDNLSSEDLKA | |
| <i>Covid-19</i> | EFLKRGDKSVYYT | ----- | SNPTTFHLDGE-VITFDNLK | TLL----- | SLREVR-TIKVFT | TVDNINLHTQV | VVDMSTYGOQ | FGFP-TYLDGAD | VTIKPHNSHE | GKTFYVLP | NDDT-LRVE | |
| <i>GCCDC1</i> | TICKYRDT--YMCH | ----- | DESNLYAITGSTVLK | FATLQKARGYMESSV | KEKTLTKVLT | VDGNVYSTVLV | DDERTFQDQIGV | -VFHNGVDI | SSRVPNSDD | ANIQLFKQDN | FSPPEVQA | |
| <i>HKU1</i> | KYFECPNSI-YICS | ----- | QKDFGYVCDG-SFYKATVN | QVCV----- | LLAKKIDVLL | TVDGVNFKSIS | LTVEVFGKILGN | -VFCDGIDV | TKLKCSDF | YADKILYQ | ENLSSADISA | |
| <i>HKU14</i> | KYFECPGGI-DICS | ----- | QKDFGYIQQG-SFYKATVS | QIKA----- | LFDKIDVLL | TVDGVNFTTRY | VPLGEVFGKTLGN | -VFCDAINV | TKCKAEQYK | GKGVVFFQ | FDNLSNADLKA | |
| <i>HKU24</i> | KYFECPGGI-SICS | ----- | QGSDFGYVQEG-TFVKATV | KEVQQ----- | LFKNVVEVLL | TVDGFNFKTKS | VVCGEAFSKVGN | -VFCENVDV | TKHIVSKE | YAGKVLYQ | FENLSEAEL | |
| <i>HKU4</i> | KLLHWSGQT--ICY | ----- | ADNKFYVKN | DVALPFS | DLEACRAYL | TSRAAQV-NIE | VLTIDGVN | FRTVILND | TTTTFRK | QLGA-TFYK | GVDISDAF | PTVKMG |
| <i>HKU5</i> | KLLNWSDQT--ICY | ----- | ADNKFYVVK | GQIALP | FDSLEKCR | TYLTSRAAQV | -NVDVLT | IDGVN | FRTVVLN | NTTYYR | VQLGS-VFYK | GSDISD |
| <i>HKU9</i> | TICKRGNT--YLCF | ----- | DDTNLYAIT | GDVVLK | FATVSKARAY | LETKLCAPE | PLIKVLT | VDGIN | YSTVLV | STAQSY | RAQIGT-VF | CDGHD |
| <i>Hedgehog-CoV</i> | KLLQWSGQT--VYV | ----- | SSNKL | FVLKNGN | LLPFTS | VEQCRSYL | NSRRTTQQL | -NVEV | LATVDG | VNFR | TIVLNN | KNTFR |
| <i>MERS-CoV</i> | KLLHWSGQT--ICY | ----- | KDSV | FYVKN | STAFP | FETLSACRAY | LD | SRTTQQL-TIE | VLTVDG | VNFR | TIVLNN | KNTYRS |
| <i>MHV</i> | KYFECPGGI-FVSS | ----- | QGKK | FGYVQNG-SF | KEASVSQIRA | ----- | LLANK | VDLCT | VDG | VNFR | SCCV | AE |
| <i>OC43</i> | KYFECTGGI-DICS | ----- | QDKV | FGYVQQG-IF | NKATVAQIKA | ----- | LFLD | KVDILL | TVD | GVNFTN | RFPV | VP |
| <i>Rat-CoV</i> | KYFECPGEI-FVSS | ----- | QGKK | FGYVQNG-L | FKVASVSQIRA | ----- | LLANK | VDLCT | VDG | VNFR | SCCV | TE |
| <i>SARS-CoV</i> | EFLKRGDKIVYHTL | ----- | ESPV | EFHLDGE-VL | SLDKL | SLL----- | SLREVK | -TIKVF | TTVD | NTNLHTOL | VDM | SM |
| <i>229E</i> | KLNRLMCDIVCTIPADYILPLVLS | SLTCNVSFVGE-L-KAAE | ----- | AKVITIKV | TEDGVNV | HDTVTTDKS | FEEQVGV-IAD | KDKDL | SGAVP | SDLNT | SELLTKA | IDVDW |
| <i>Bat-CoV-1A</i> | KLSKLGSSVCSFSTLDMHKRLLN | LFN--KFCVDNID--DI----- | ----- | KDIHDT | KTTIKV | SLDGRNV | VDDVDAAD | QTIGE | QLNA-CTT | DNVI | ISDS | VVTD |
| <i>BtCoV512</i> | KFLKLGKSLLVVVEDSSVFNKISHA | ---SVAGYVA--KPALV----- | ----- | DTLFE | AKPVQ | VVTTQD | QRSFHT | VELST | SQTYG | QQLGD-CV | VEDK | VTNL |
| <i>BtMr-AlphaCoV</i> | KVSKLEGRVIC | TPKQVLMALKTFPSNYAFLVHDS | ---AKSTV----- | DDCF | SLAQYK | VQTTED | GVNVNT | VISNA | KTYGE | QLGS-VT | VADSD | ISAT |
| <i>BtNv-AlphaCoV</i> | KLSKLGKGNILSTVSSVMFA-RLTRVW | ---KSFWLCD--SVSVV----- | ----- | DEHF | SETS | VVVTE | NGRDF | FETAL | DAKT | FVEQ | VGCV-CTI | DN |
| <i>BtRf-AlphaCoV</i> | KITKLGKGNVSTVPPPTSVLKNMLKCCN | ---CSFVVSQD--TKASV----- | ----- | TECF | DVQEV | RKVS | SYNDR | VDQV | VVKG | DKVID | QIGP-CST | NN |
| <i>CDPHE15</i> | KCLKLGKTCVYATTDADVLRRIVKH | ---SCFGFIA--NDNVI----- | ----- | SAVF | TGQ | FRVE | TQD | QRTYS | VKSL | DASK | TMG | ELGT-C |
| <i>FCoV</i> | ----- | ----- | ----- | PIKV | TED | TVNQR | VSV | ALDK | TYGE | QLKGT | VVIK | DKD |
| <i>Ferret-CoV</i> | ----- | ----- | ----- | TVL | LED | GP-SVQ | VVLE | PVVA | IDS | QLASK | VVN | KNV |
| <i>HKU10</i> | KVSKLKGKIFCTIPTVDVMQMLKCCN | ---TSFIVTDA--TKTRL----- | ----- | SECF | ESAV | VEVK | VTHD | GRD | VHTV | VKT | DV | VL |
| <i>HKU2</i> | KLARLDGSTLCVLPNASALFDKLFALGDN | FSLVLDN---VRPLF----- | ----- | DNYL | KPKD | VKVT | ADGR | NVND | VVTT | AE | TFDA | QLGP-S |
| <i>HKU8</i> | KLAKLKGVSSTFSTIDVHKRLLAFVK | ---LFCVASMD--VV----- | ----- | GDVH | TP | SVK | VTD | GR | TVK | VV | ST | TT |
| <i>LuchengRn-CoV</i> | ----- | EEVLA-----A--RTNTE----- | ----- | SDDS | DEE | I | VT | LV | TED | TVNY | TTT | S |
| <i>Mink-CoV</i> | ----- | ----- | ----- | TVV | V | K | DCN | -KV | T | KN | V | DA |
| <i>NL63</i> | KLNRLKTCVIANVPAIDVLKLLSSLTLTVK | FVVE-S--NVMDV----- | ----- | NDCF | KND | NV | V | LK | TED | G | IN | V |
| <i>NL63-related</i> | KLNKLIKCVVANMPSIDVLKLLSNLAIDV | KFAAE-G--KTSDV----- | ----- | NGCF | KSD | NV | V | LK | V | TED | G | IN |
| <i>Porcine-EDV</i> | KVSKLKGKLVLAVDATLYSKLSHL | ---SVLGFVS--TPDDV----- | ----- | ERFY | ANK | SV | V | K | V | TED | TR | S |
| <i>TGE</i> | ----- | ----- | ----- | PVNV | TED | NV | N | HER | V | S | S | F |



2670 2680 2690 2700 2710 2720 2730 2740 2750 2760 2770 2780 2790

Bat-BCoV VK EY Y G V E D T S F L T R Y N S A L M H V N R W S F A E V P S T G I F C I K W V A N N C Y L N A A I L M L Q Q L - N V E Y E T P A V R E A A F E M R A G K P Q R F V A L M I A Y L K A T I G H T G D A R E A V R T M L S H A K V Q - G E - R H F V - - - M

Bovine-CoV V R S S F N F D Q K E L L - A Y Y N M L V N C S K W Q V V F N - - G K Y F T F K Q A N N N C F V N V S C L M L Q S L - N L K F K I V Q W Q E A W L E F R S G R P A R F V S L V L A K G G F K F G D P A D S R D F L R V V F S Q V D L T - G A I C D F E - - - I

Covid-19 A F E Y Y H T T D P S F L G R Y M S A L N H T K K W K Y P Q V - - N G L T S I K W A D N N C Y L A T A L L T L Q Q I - E L K F N P P A L Q A Y Y R A R A G E A N F C A L I L A Y C N K T V G E L G D V R E T M S Y L F Q H A N L D - S C R V L N - - - V

GCCDC1 I S D Y Y G V N D C T V V A R A L S V R R Y V R T W P Y S V V - - D G R V L L A Q R D S N C Y L N A A I S V L Q D I - E V E F S T P W L S T A F D A L K G N P L P I V E V L I T L G K T T I G E P D A H M I L S S L S Y A S V K - A A R R A I T - - - T

HKU1 V Q S S F G F D Q Q Q L L - A Y Y N F L - T V C K W S V V V N - - G P F S F E Q S H N N C Y V N V A C L M L Q H I - N L K F N K W Q W E A W Y E F R A G R P H R L V A L V L A K G H F K F D E P S D A T D F I R V V L K Q A D L S - G A I C E L E - - - L

HKU14 V K S S F N F D Q K E L L - A Y Y N V L V S C G K W Q I V V N - - G K Y F T F K Q A N N N C F V N A A C L M L Q N V - N L K F V S M Q W Q E A W L E F R A G K P L R F V A L V Y A K A F K F G D P A D S R D F I R V V L S Q T D L A - E A C D Y E - - - F

HKU24 V K Q S F G F D Q K Q L L - A Y Y S Y - R S C C R W E V V V H - - R K W F C F K Q A D N N C Y C N A A C L M L Q N L - N L T F K L Q Q W Q E A W L E F R A G R P L R F V A L V L A K G A F V Y G Q P A D A R D F M R V A L S Q A D L S - S A S C E Y E - - - F

HKU4 L K E Y Y G T S D V T F L Q R Y Y S L Q P L V Q Q W K F V V H - - D G V K S L K L S N Y N C Y I N A T I M M I D M L H D I K F V V P A L Q A A Y L R Y K G G D P Y D F L A L I M A Y G D C T F D N P D D E A K L L H T L L A K A E L T V S A K M V W R - - - E

HKU5 L S E V Y G T A D T A F L H R Y Y S L L A L V K K W K Y T V H - - D G V K S L K L S N N C Y L N V T M L M L D M L K E I K F I V P A L Q A A Y Y R A G D A N F C A L I L A Y S N K T V G E L G D V R E T M T H L L O H A N L E - S A K M V L N - - - Q

HKU9 I R E Y Y G V D D S N I I A R A M S I R K T V Q T W P Y T V V - - D G R V L L A Q R D S N C Y L N V A I S L Q D I - D V S F S T P W V C R A Y D A L K G N P L P M A E V L I A L G K A T P G V S D D A H M V L S A V L N H G T V - - T A R R V M Q - - - T

Hedgehog-CoV V K E M Y G V E D P T F L Y K Y S I R A K V V K W K M A M C - - E D A P S L C L N S N N C Y L N A A V M M L D C L R D I K F N I P A L Q A A Y M K F K G G D F G D F I S L L M A Y G N C T Y G Q P D D A S M L L H T A L S K A E L L V S A R M V W R - - - E

MERS-CoV L K E L Y G P V D P T F L H R F Y S L K A A V H G W K M V V C - - D K V R S L K L S D N N C Y L N A V I M T L D L L K D I K F V I P A L Q A H A F M K H K G D S T D F I A L I M A Y G N C T F G A P D D A S R L L H T V L A K A E L C C S A R M V W R - - - E

MHV V K D A F G F D E P Q L L - K Y Y T M L - G M C K W P V V V C - - G N Y F A F K Q S N N N C Y I N V A C L M L Q H L - S L K F P K W Q W Q E A W N E F R S G K P L R F V S L V L A K G S F K F N E P S D S I D F M R V L R E A D L S - G A T C N L E - - - F

OC43 V R S S F N F D Q K E L L - A Y Y N M L V N C F K W Q V V V N - - G K Y F T F K Q A N N N C F V N V S C L M L Q S L - H L T F K I V Q W Q E A W L E F R S G R P A R F V A L V L A K G G F K F G D P A D S R D F L R V V F S Q V D L T - G A I C D F E - - - I

Rat-CoV V K D A F G F D E P Q L L - K Y Y N M L - G M C K W P V V V C - - G N Y F A F K Q S N N N C Y I N V A C L M L Q H L - N L K F P K W Q W Q E A W N E F R S G K P L R F V S L V L A K G S F K F N E P S D S T D F I R V L R E A D L S - G A T C D L E - - - F

SARS-CoV A F E Y Y H T L D E S F L G R Y M S A L N H T K K W K Y P Q V - - G G L T S I K W A D N N C Y L S S V L L A Q L - E V K F N A P A L Q E A Y Y R A R A G D A A N F C A L I L A Y S N K T V G E L G D V R E T M T H L L O H A N L E - S A K M V L N - - - V

229E - V E F Y G F K D A V T F A T - - - V D H S A F A Y E S A V V - - N G I R V L K T S D N N C W N A V C I A L Q Y L - K P H F I S Q L G D A A W N K F V L G D V E I F V A F V Y V A R L V K G D K G D A E D T L N K L S K Y L V N E A Q V Q L E H Y - - - S

Bat-CoV-1A - D S F Y G F P H A A E F H M - - - L D H S A F A F D N D V V - - D G K R A L V G T D N N C W I N A V C L Q L Q F A - E V D F T S E G L K D M W N E F L V G N V A K F C H W I Y W L V R A N K G D A G A E N A L N M L N K Y V K A H G T V L T R E - - - T

BtCoV512 - D K H Y G F V D A G I F H T - - - L D H T M F V F D N N V V - - N G K R V L R T S D N N C W I N A V C L Q L Q F A - N A K F K P K G L Q Q L W E S Y C T G D V A M F V H W L Y W I T G V E K G E P S A E N T L N I I S R F L K P Q G S V E M L R A T S T T

BtMr-AlphaCoV - V S H Y G F S D A A A F A T - - - F D H T P F A F D S D M V - - M G K R A L A Q T D N N C W I N A A C L A L Q Q L - K P K F K P G L E A A W N K Y V T G D C G E F V H F L Y H I T R S R K G D L G D T E N L L N L D K Y I V A S G T V V L E R H - - - V

BtNv-AlphaCoV - D A F Y G F E N A S V F H T - - - L D H S G F E F E S T V V - - E G K R T L K S D N N C W N A V C L Q L Q Y L - D A K F Y G W E D L W N K L R S G D V A G F V H L L Y I E G V D K A G K G D V E S T L S K L D K Y I V S S G S V T V E R S - - - T

BtRf-AlphaCoV - I S H Y G F P R A D V W H T - - - L D H S A Y D Y E S K E Q - - - D G V R V L K F S D N N C W N A T C I Q L Q I A - K I T F R T E G I Q A M W D E F L V G V A K F V H W L Y W Y Q N S S K G D P G D V E Y T L N A I S R Y M A N K S T V V I S R V - - - A

CDPHE15 - D V H Y G F V G A A S F H I - - - L N H E A F E Y P S S V Q - - - N G K R V L K T S D N N C W N A V C L Q L Q F A - N A K F V G T G L Q T L W D E Y L V G N V A G F V H W L Y W L A G V Q K G D P G D A E D T L N L I S K F L Q S Q G H V V D R T - - - T

FCoV - N A Y Y G F P N A A A F S A - - - S S H D A Y E F D V V T H - - - N N F I V H K Q T D N N C W N A I C L A L Q R L - K P T W K F P G V K S L W D A F L T R K T A G F V H M L Y H I S G L T K G Q P G D A E L T L H K L V D L M S S D S A V T V T H T - - - T

Ferret-CoV - S S Y Y G F A N A D T F S A - - - L N H D E F V F E S T I V - - - D G F V V F K Q T D N N C W N A T C M L L Q N L - K P T W R F K G M E D L W S K F V S G N T A P F V H L L Y F I I K A K R G D P N D V E F V L H K L E P L L C E S G S V T L D N F - - - K

HKU10 - I S Y Y G F P R A D L Y H T - - - L D H K Q Y A Y E N S D V - - - E G K R V L K F S D N N C W V N T I C L Q L Q F A - K A I F K T E G L Q A M W D E F L T G R V E R F V H W L Y W Y Q N I E K G Q P G D V E Y L L G K I S R Y L V N S G T V T I S K - - - -

HKU2 - S K H F G F S D A A A F A V - - - L D H S K F A F D S E V V - - - D G K R A L A D S D N N C W N A T C L A L Q F L - K P T F K Y V G W E D L W N K L R S G D V A G F V H L L Y I E G V D K A G K G D V E S T L S K L D K Y I V S S G S V T V E R S - - - T

HKU8 - D S H Y G F K D A G N F H V - - - L D H S A Y A Y D S D F V - - - D G K R A L A G S D N N C W N A T C L Q L Q F A - G V E F L S K G V T A M W N E F L T G D V A R F V H W L Y W L N G A S K G D L G D V E T T L N L V A K H A K P K G C V T I E K T - - - T

LuchengRn-CoV - E S Y Y G F D A - A S F C A - - - V S H N D Y N F G C V I D - - - D G V V A L T Q D R N N C W L N A V C L S L Q M L - K P Q F K F D I K K L W D E F C T G D V A G F C H F V Y F T S N I S L G S K A D A E V V L R K L S G F I E S D N S V V H M V C - - - T

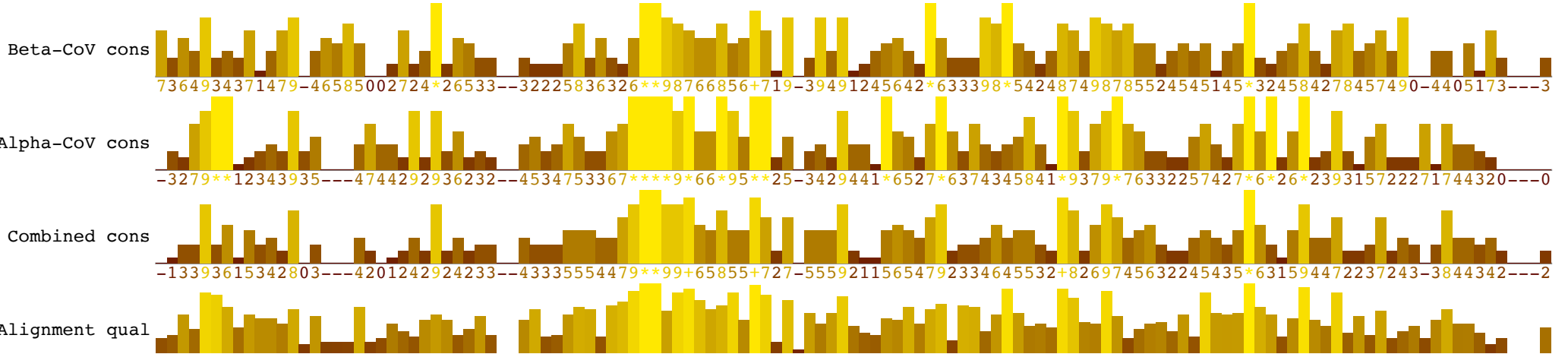
Mink-CoV - C G H Y G F E N A A V F S A - - - S D H S D Y K F E S A I V - - - N D K I V F K Q S D N N C W N S L C L L L Q D Y - - - K P T W R F P G M E D L W S K F V S G T P E F V H F L Y F I T G T T K G Q P N D V E L A L H K L E P L L C A S G S V T L D E F - - - S

NL63 - V A F Y G F E K A A L F A S - - - L D V K P Y G Y P N D F V - - - G G F R V L G T T D N N C W N A T C I I L Q Y L - K P T F K S K G L N V L W N K F V T G D V G P F V S F I Y F I T M S S K G Q K G D A E E A L S K L S E Y L I S D S I V T L E Q Y - - - S

NL63-related - V N F Y G F D N A A L F A S - - - L D T K P Y N P N D F V - - - N G F R V L K T T D N N C W I N A T C I T L Q Y L - K P N F K S E G L N A L W N K F V T G D V G P F V S F I Y F I T G S T K G Q K G D S E E T L S K L S E Y L V S D S V T L E Q Y - - - T

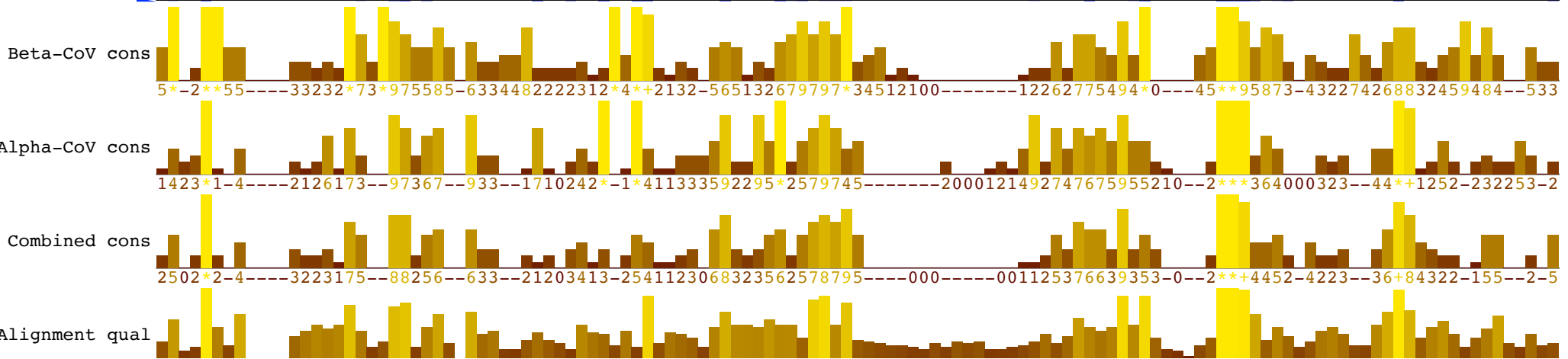
Porcine-EDV - D S H Y G F D K A G E F H M - - - L D H T G F T F P S E V V - - - N G R V I K T T D N N C W N V T C L Q L Q F A - R F R F K S A G L Q A M W E S Y C T G D V A M F V H W L Y W L T G V D K G Q P S D E N A L N M L S K Y I V P A G S V T I E R V - - - T

TGE - O A H Y G F R D A A A F S A - - - S S H D A Y K F E V V T H - - - S N F I V H K O T D N N C W I N A I C L A L Q R L - K P O W K F P G V R G L W N E F L E R K T O G F V H M L Y H I S G V K K G E P G D A E L M L H K L G D L M D N D C E I I V T H T - - - T



2800 2810 2820 2830 2840 2850 2860 2870 2880 2890 2900 2910 2920

Bat-BCoV MCKKCGIR---RSQFHGLDAVMCFITNTQLSDFLSGDEAGCTCGDIVPVYQTHIRVPFLILSTTEPKMQML---NCEDTKFLCANNYMGTL-L-SSGHYTHVF-NKTLLYSVNGTRVTKMSE--TTT
Bovine-CoV AC-KCGVK---QEORTGVDAMHFGT-LSREDLEIGYTVDCSCGKKLI-HCVRFDVPFLICSNTPASVKL-----PKGVTGSANIFKGD---KVGHYVHVK-CEQSYQLYDASNVKKVTD--VTG
Covid-19 VCKTCGQQ---QTTLKGVAVMYMGT-LSYEQFKKGVQIPCTCGKQATKYLVOQESPFVMSAPPAQY---ELKHGTFTCASEYTCN-Y-QCGHYKHIT-SKETLYCIDGALLTKSSE--YKG
GCCDC1 VCENCGSS---QEIEGVPAACLHYGT-VQLDDLKYPESIVCPCGKAAIRFVSLQQTPTWLLMSHVPNTNVPL-----DTTGNWFSAVVFKGP-V-TCGHYMYAV-NGSLISYVDANTRRKRTSD--LLV
HKU1 IC-DCGIK---QESRVGVDAVMHFGT-LAKTDLFNGYKIGCNCAGRIV-HCTKLNVPFLICSNTPLSKDL-----PDDVVAANMFMCV---GVGHYTHLK-CGSPYQHYDACSVKKYTG--VSG
HKU14 VC-KCGVK---QEORTGIDAMHFGT-LSREDLEKGYTIDCSCGDKLI-HCTRINVPFLICSNTPKDSVV-----PKGVTCANVFIGG---NVGHYTHLR-CDSSYQLFDASTVKKITTT--VNG
HKU24 IC-KCGVK---VEKRDGIDAMFYGT-CDKQALEKGTITDCSCGPKTV-HVLSMNVPFFIGSQAPAVGAL-----PNGCAAANLYKGG---AVGHYTHVK-NGKQLTCFDAHNVKKCTT--LVD
HKU4 WCTVCGIR---DIEYTGMRACVYAGV-NSMEELQSVFNETCVCGSVKHRQLVEHSAPWLLVSLNEVKVS---TSTDPIYRAFNVFQGVET-SVGHYVHIRVKDGLFYKYDSGSLTKTSD--MKC
HKU5 WCNVCGVQ---DTTTLGLKACIYVGM-NSLDELHATHEECCQCGDVRKQQLVEHNAPWLLSGLNEAKVMTPTSQSAGPDYTAFNVFCQVET-SVGHYLVHVRVKDNLKYDSGSLTKTSD--MKC
HKU9 VCEHCGVS---QMVFTGTDCTFYGS-VVLDDLKYPVSVVCQCGRPAIRYVSEKSPWLLMSCTPTQVPL-----DTSGIWKTAIVFRGP-V-TAGHYMYAV-NGTLISYVDANTRRRTSD--LKL
Hedgehog-CoV WCDHCGVK---DVVITGIKACVYVGV-QSLDELRECNHHCQCGGVRFRQLVECVTPWLLSGPPNEELV-----ANPDFVAFNVFIGHEA-GVGHYVHARVKKGLLYKYDSGTLTKASD--WKC
MERS-CoV WCNVCGIK---DVVLQGLKACCYVGV-OTVEDLRARMTYVQCQGERHRQLVEHTTPWLLSGTPNEKLV---TSTAPDFVAFNVFQGIET-AVGHYVHARLKGGLILKFDSTGTVSKTSD--WKC
MHV VC-KCGVK---QEQRKGVDAVMHFGT-LDKGDLVRGYNIACTCGSKLV-HCTQFNVPFLICSNTPEGRKL-----PDDVVAANIFITGG---SVGHYTHVK-CKPKYQLYDACNVKQVSE--AKG
OC43 AC-KCGVK---QEORTGLDAMHFGT-LSREDLEIGYTVDCSCGKKLI-HCVRFDVPFLICSNTPASVKL-----PKGVTGSANIFIGD---KVGHYVHVK-CEQSYQLYDASNVKKVTD--VTG
Rat-CoV IC-KCGVK---QDQRKGVDAVMHFGT-LDKSDDLKGYNIACCTCGSKLV-HCTQFNVPFLICSNTPEGRKL-----PDDVVAANIFITGG---SLGHYTHVK-CKPKYQLYDACNVKQVSE--AKG
SARS-CoV VCKHCGOK---TTTTLTVGEAVMYMGT-LSYDNLKTVSIPCVCGRDATQYLVQOESSFVMSAPPAEY-----KLOQGTFLCANETGNY-Y-OCGHYTHIT-AKETLYRIDGAHLTKMSE--YKG
229E SCVECDAKFKNSVTSINSA--IVCAS--VKR--DGQVQGYC-VHGIKYYSRVKSVRGRAIIVSV---EQLEPCVQRLLSGVAYTAFSGPVD--KGHYTVYDTAKKS--MYDGRFV-KHDLSSL-L
Bat-CoV-1A AEGCCV-N---EHRINSF--VYNAS--VLR--SGCNDGYC-KHGNAYIARVSKVDGVSIVNV---DRPSVMSDNLSSGTSYTAFTSGPMD--SGHYRVFNPAATSK--MFDGANCI-GDLCN-L
BtCoV512 CDGTC-S-T---KRVVSTP--VYNAS--VLK--VGLDDGNC-VHGLPLVDRVSVNGTIVITITNVGDTGPKPVVATENLLLDGVSYTVFQDSTTG-VGHYTVFDKEAKL--MFDGDVVK-PCDLNV-S
BtMr-AlphaCoV DCPTCNST---ERTINAS--VVSAS--LSR--DGSDDGVCACAGVDYVLRVVKHVGKDVIIITC---EQPKCYKSEILMGEAYVAFTGPIS--GGHYLVYDRATGQ--VFDGNKCL-PYDFDT-L
BtNv-AlphaCoV SSLCCS-E---LRTYNAC--VVSAS--VLR--NGVSDGVC-KHGDAYKSRVSAVDGIGIVSV---SIPDPVPKSAALDGVSYTFTGDVG--SGHYAVVDRKLYK--SFDGFDVK-PASLSS-V
BtRf-AlphaCoV TTECCN-D---TKTIHTP--VNVNS--LLR--SGVEDGVC-QHGNKYYSRLVSVKGTIVITST---GKPNVYPRNALITGDSYTLVSGDVK--DGHYTVFSVKGDK--IFDGENVSSNNDLSSL-Y
CDPHE15 VDSCCS-S---QRTLVTTP--VVNGS--ILR--MGVDDGAC-KHGSTFINKVVSINGTVILNV---GPPISSAPTSFIQGLSYTSFNNTV-GGVGHYTVYDSTQHG--FYDGDVVFV-RGELAM-Q
FCoV ACDKCA-K---VETFTGP--VVAAP--LLV--CGT-DEIC-VHGWHVNVKVTISIRGTVAITSL-----IGPVVGDVIDATGYICYTGLNS--RGHYTYDNRNGL--MVDADKAY-HFEKNL-L
Ferret-CoV GCDICY-K---PSVVTGA--VVAAP--LQA--KGD--NMVC--THGKSVTRVTKVQGSVVLST---CGV-VSNSIKGDGYVCFNGSAS--SGHYTYSS-RNGT--VYDADKTY-TFKVDD-L
HKU10 DSVCN-S---KRTLTP--VVEAS--ILK--SGFDDGVC-KHGNACVSRISAVRGTIVIVIT---GKPKVYPRALIDGDTYTTYSGSVE--DGHYTVFETKNSR--VYDGDVSTGNDLST-H
HKU2 LCDRCNST---VKTVTGA--IAEAS--VIL--NGHADGHC-PHNFVWRVQVVGKGDIIILLHS---GSL--NGPVYGDAYVAFSGNID--NGHYTVFDNKLSK--MYDGIKCV-KTTLDT-L
HKU8 VDGCCV-S---EKRVNSL--VYNAS--VLR--QVGDGYC-QHGNKYYSRLVSVKGTIVITST---GKPNVYPRNALITGDSYTLVSGDVK--DGHYTVFSVKGDK--IFDGENVSSNNDLSSL-Y
LuchengRn-CoV QCVDCED---LVRTDGA--VIVSS--LSR--GNVVSQK-EGYCRNVIVQRITGDCILTSS-----KPCVSDQYITNVGRILYNGDES--NGHYTFYDCFRGR--LYDGSVFTLQGVASVKA
Mink-CoV GDCCY-N---RSTISGP--IVAVP--LQT--LGD--KAVC-RHGVRVTRVHKIQGSVILTSI-----NGS-VTDCCLKGDGYVCFNGSKD--RGHYTYSS--SGV--MYDADKTY-PFKVSD-L
NL63 TCDICKST---VVEVKS--IVCAS--VLK--DGCVDGFC-PHRHKLRSRVKVFVNGRVVITNV---GEPISQPSKLLNGIAYTTFSGSFD--NGHYVVYDAANNA--VYD GARLF--SSDLST-L
NL63-related TCDLCESN---ITTVKGA--VVCAS--VLK--DGCVEGFC-PHRHKLRSRVKSVRGRVITNV---DRPVVAQPSRLLNGIAYTAFSGPVD--SGHYTVYDSLTKS--IYDGRFV-ASDLST-L
Porcine-EDV HDGCCS-S---KRVVTAP--VYNAS--VLK--LGVEDGLC-PHGLNYIGKVVVVKGTIVIVNV---GKPVVAPSHLFLKGVSYTFTLDNGNGVVGHYTVFDHGTGM--VHDGDAFV-PGDLNV-S
TGE ACDKCA-K---VEKFVGP--VVAAP--LAI--HGT-DETC-VHGVSVNKVTQIKGTVAITSL-----IGPIIGEVLEATGYICYSGSNR--NGHYTYDNRNGL--VVD A EKAY-HFNRL-L



2930 2940 2950 2960 2970 2980 2990 3000 3010 3020 3030 3040

Bat-BCoV AVADAVYKDI-KYDTEdqfVtYRLdGVWcHEKNpDLsVYyKSGsDYtSAP-IDLTpTEpLsGAeyDNfHLkLVGtLDDnkVkfVQEFnHMVKYDKTKP-TRpVtISfYpEMEGdVVALsADKLQqH

Bovine-CoV NLSdCLYLkNLKQTFKsVLTtTYyLDDvKkIEYnPDLSQYYCDGgKYtQRiIkaQfKtFEKvDgVYtNfKlIG-----HTICdILNAKLGfDSSKE-FVEYKvTEWpTATgDVVlATDDLYVkr

Covid-19 PITdVfYkEN-SYtTtIKpVtYkLdGVVctEIdPKLDnYyKkDnsYfTEQp-IDLVPnQpYpNAsFDnFkFVC-----DNIkFADdLNQlTgYkKp-A-SRELKvTFFpDLNgDVVAIDYkHYtPS

GCCDC1 PATdILYkDv-NfTtSskVvTfYLDgVklTQIDpDLtQYyVkrGDYyftKAP-IDVVAA-pkVvTpyDgFrlVs-----DQASELAeAFnKAINAsSDGP-KR--SLtVYpDCSGDAVVVNE-EIP-S

HKU1 CLTDCLYLkNLtQTFtSMLtNYfLDDvEMvAYnPDLSQYYCDNgKYtKPIIkaQfKpFAKvDgVYtNfKlVg-----HDICAQLNDKLGfNVdLp-FVEYKvTVWpVATgDVVlASDDLYVkr

HKU14 KITdCLYLkNLKQTFrSVLTtTYyLDDvKkVEYnPDLTQYYCEGgKYtQRiIkaQfRtFEKvDgVYtNfKlVg-----HTICdSLNAKLGfDANKH-FEEfKvTEWpIATgDVVlVtDDMYVkr

HKU24 GVTdCLYtNVPKQTFESCLtTYyLDDvKHVEYkPDLsQYYCEGgRYtQRiVkaQfKtFEAVDgVYtNfELVg-----HALCDtLNvKLGfDStKd-SVQYKvTVWpDATgDVVlADDDLYVkr

HKU4 KMTsVwYpTV-RYtADCNvVvYdLDgVtKVEVnPDLSnYyMkDgKYtSKptIKYsPatILpGSvYtNSCLVgVdGtP-GSDtISkFFnDLlGfDEtKpISkKlTYSLLPNEDgDVLLSEfSNYNpV

HKU5 KMTdVYyPKQ-RYSADCNvVvYSLDgNTwADvDpDLsAFyMkDgKYtTKpVIEYsPatILsGSvYtNSCLVgHDGtI-GSDAIsSfNnLlGfDnSKpVSKKlTYSFFpDFEGdVILtEYStYdPI

HKU9 PATdILYgpt-SfTtSdSkVetYyLDgVkrTtIDpDfSKYvkrGDYyftTAP-IEVVAA-pklVtSYdGfYlSS-----CQNPQlAESfNkAINAtKtGP-MK--LLtMYpNvAGDVVAISDDNVV-A

Hedgehog-CoV KVTdKLYpGQ-KYtAECEIvVYSLDGNQkAEKQpNfSAYyVkdGKYtNKpSLEfTPATvSSGvYtNSCFIVNdG-----DAIGsAFnKlLgFDknKpASKlTYSLLPNEDgDVLLAEfKSYDPM

MERS-CoV KVTdVLFpGQ-KYSSdCNvVrYSLDGNfRtEVDpDLsAFyVkdGKYtSEppVtYsPatILAGsvYtNSCLVSSDgQp-GGDAIsLsFNnLlGfDSSKpVTKKYtYSfLpKEDgDVLLAEfDtydPI

MHV NfTDCLYLkNLKQTFSSVLTtTYyLDDvKcVEYkPDLsQYYCESGKYtKPIIkaQfRtFEKvDgVYtNfKlVg-----HSIAEKLNAKLGfDCNSp-FVEYKITEWpTATgDVVlASDDLYVsr

OC43 KLSdCLYLkNLKQTFKsVLTtTYyLDDvKkIEYkPDLsQYYCDGgKYtQRiIkaQfKtFEKvDgVYtNfKlIG-----HTVCDsLNAKLGfDSSKE-FVEYKITEWpTATgDVVlATDDLYVkr

Rat-CoV NfTDCLYLkNLKQTFSSVLTtTYyLDDvKcVEYkPDLsQYYCESGKYtKPIIkaQfRtFEKvDgVYtNfKlVg-----HSIAEKLNAKLGfDCDSp-FVEYKITEWpTATgDVVlASDDLYVsr

SARS-CoV PVTdVfYkET-SYtTtIKpVtYkLdGVtYtEIEpKLDGyYkKNAYtEOP-IDLVpTOpLpNAsFDnFkLTC-----SNTkFADdLNOMtGfTKp-A-SRELsvTFFpDLNgDVVAIDYrHYsAS

229E SVTS-----

Bat-CoV-1A AVTA-----

BtCoV512 PVTs-----

BtMr-AlphaCoV TISA-----

BtNv-AlphaCoV SVTG-----

BtRf-AlphaCoV PVTs-----

CDPHE15 PVTA-----

FCoV QVTT-----

Ferret-CoV SVTS-----

HKU10 AVSS-----

HKU2 VASS-----

HKU8 AVTS-----

LuchengRn-CoV PVSS-----

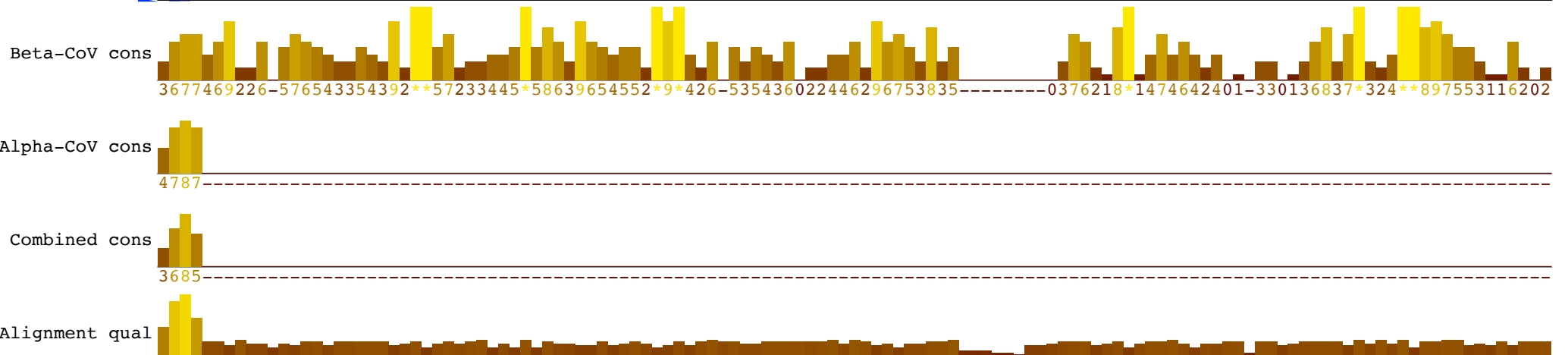
Mink-CoV SVTS-----

NL63 AVTA-----

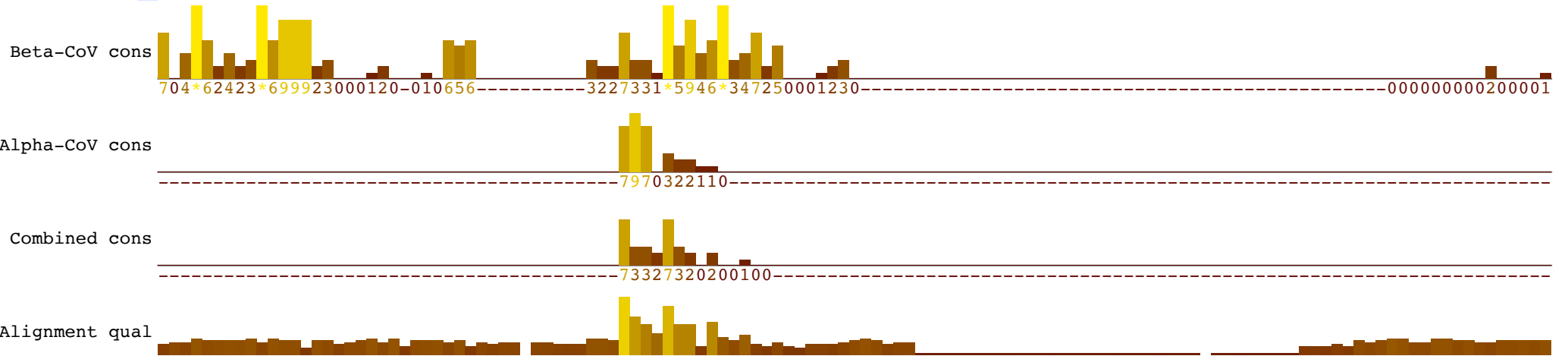
NL63-related SITA-----

Porcine-EDV PVTN-----

TGE OVTT-----



| | 3050 | 3060 | 3070 | 3080 | 3090 | 3100 | 3110 | 3120 | 3130 | 3140 | 3150 | 3160 | 3170 |
|----------------------|---------------------|---------------------|-------------------|------------------|------------------|---------------|------------|----------------|-------------|-------------|-------------|--------------------|-------------------|
| <i>Bat-BCoV</i> | FKKGAKFGSKFIVWHTGYK | ITR-DLVKPNMAAM-RCIT | TTSKPVTTQNSFQALS | VEPLPETKHSEHELAT | ----- | ----- | ----- | ----- | ----- | ----- | ----- | EQKPILKLRTEKPVVTAA | ---- |
| <i>Bovine-CoV</i> | YERGCITFGKPVIVLSHEQ | ASLNSLTYFN----- | ----- | ----- | RPLLVDENKFDVLKVD | VDDVDDGGDISES | ----- | ----- | ----- | ----- | ----- | ----- | DAKESKEINI I KLSG |
| <i>Covid-19</i> | FKKGAKLLHKPIVWHVNN | ATNK-ATYKPN | TWCI-RCLWSTKPVETS | NSFDVLKSEDAQGM | NLA--CE | ----- | ----- | ----- | ----- | ----- | ----- | DLKPVSEEVVENPTIQ | KDVL |
| <i>GCCDC1</i> | YAHGALIQGKPVLYPK | ----- | KPKTWKKLVPLLSV | LEVTKNRF | FEALPVDQLPEQ | TVEVV----- | ----- | ----- | ----- | ----- | ----- | KK-HKVA | ----- |
| <i>HKU1</i> | YFKGCETFGKPVIVFCH | DEASLNSLTYFN | ----- | ----- | KPSFKSENRYSVLS | VDSVSEESQGNV | VTSV----- | ----- | ----- | ----- | ----- | ----- | MESQISTKEVKLKG |
| <i>HKU14</i> | YEKGCITFGKPVIVWYH | DQASLNSLTYFN | ----- | ----- | RPSLVDVNFDFVLK | VDDVVAEVES | CS--DL | SHGSLSGSVSTGSS | SYLSPQGNQGS | NVEAHTTVLAS | GNQGSNAINGS | SANSNKIV | KLNG |
| <i>HKU24</i> | YKKGCIITFGKPVIVQ | SHMEASLASLTYFN | ----- | ----- | RPSLIDKNKFDVLT | VVEESALEEK | DD----- | ----- | ----- | ----- | ----- | ----- | SQVGPFI I KKLKN |
| <i>HKU4</i> | YKKGVMKGGKPIVWV | NNGVCD | -ALNKP | NRASL-RQ | LYDVAPIVLDNK | YTVLQDN | TSQLVEHN | VPVVD----- | ----- | ----- | ----- | ----- | DVPITTRKLI |
| <i>HKU5</i> | YKNGAMLHGKPIVWV | NNSKFD | -ALNKF | NRATL-RQ | VYDIAPVTLEN | KYTVLQDN | QIQVEVE | APKEDA----- | ----- | ----- | ----- | ----- | KPQSPVQVAED |
| <i>HKU9</i> | HPYGLHMGKPVLFVT | ----- | RPNTWKKLVPL | STVVTNPT | YDVLAVDPL | PVNNETSE | ----- | ----- | ----- | ----- | ----- | ----- | EPI |
| <i>Hedgehog-CoV</i> | YKNGAAYKGGKPIVW | VNGLYD | -KLNK | YNRASL-RQ | IFDIQPVETN | NRFAPL | KVEE | VDERPTSHVQE | ----- | ----- | ----- | ----- | ETLVSEKSEL |
| <i>MERS-CoV</i> | YKNGAMYKGGKPIVW | NKASYD | -NLNKF | NRASL-RQ | IFDVAPIELEN | KFTPL | SVEST-- | PVE----- | ----- | ----- | ----- | ----- | PPTVDVVAL |
| <i>MHV</i> | YLSGCITFGKPVVW | LGH | EASL | KSLTYFN----- | ----- | RPSVVCENKFN | VLPVDV | SEPTDKGPV | AAVLVTG | VPGADASAG | AGIAKEQ | KACASA-S | VEDQVVTEV |
| <i>OC43</i> | YERGCITFGKPVIVLS | HEKASLNSLTYFN | ----- | ----- | RPSLVDNKFDFVLK | VDDVDDGGD | SSSES----- | ----- | ----- | ----- | ----- | ----- | GAKETKEINI |
| <i>Rat-CoV</i> | YLSGCITFGKPVVW | LGH | EASL | KSLTYFN----- | ----- | RPSVVCENKFN | VLPVDV | SEPTDKGPV | AAVLVTG | VPSADAS | ADAGTAKE | QKACASD-N | VEEQVVTEV |
| <i>SARS-CoV</i> | FKKGAKLLHKPIVWH | I | NOATK-TTFK | PN | TWCL-RCLW | STKPVDT | SNSE | FLAV | EDTOGMD | NLA--CE | ----- | ----- | SOOPTSEEV |
| <i>229E</i> | ----- | ----- | ----- | ----- | VVMVGDY | VAPVS----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Bat-CoV-1A</i> | ----- | ----- | ----- | ----- | VVIK | NKVF | KIQ | TAD----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtCoV512</i> | ----- | ----- | ----- | ----- | VVVC | NNKI | --- | VVQDP | ----- | ----- | ----- | ----- | ----- |
| <i>BtMr-AlphaCoV</i> | ----- | ----- | ----- | ----- | VVV | GGY | VCS----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>BtNv-AlphaCoV</i> | ----- | ----- | ----- | ----- | VVK | TAK | FTRK | VQVATP | ----- | ----- | ----- | ----- | ----- |
| <i>BtRf-AlphaCoV</i> | ----- | ----- | ----- | ----- | VVS | NK | VIE | FEK | ----- | ----- | ----- | ----- | ----- |
| <i>CDPHE15</i> | ----- | ----- | ----- | ----- | LVA | -R | SHY | --- | VVKDP | ----- | ----- | ----- | ----- |
| <i>FCoV</i> | ----- | ----- | ----- | ----- | AIAS | NFV-ANT | PKKE | IMP | KTQAKESKA | ----- | ----- | ----- | KESNTAR |
| <i>Ferret-CoV</i> | ----- | ----- | ----- | ----- | VLML | TG | YK | LP | VVH----- | ----- | ----- | ----- | ----- |
| <i>HKU10</i> | ----- | ----- | ----- | ----- | VV | ANK | L | F | DDPIEV | ----- | ----- | ----- | ----- |
| <i>HKU2</i> | ----- | ----- | ----- | ----- | VV | IR | NG | S | YAV----- | ----- | ----- | ----- | ----- |
| <i>HKU8</i> | ----- | ----- | ----- | ----- | VVV | VN | K | F | KA | EV | CN----- | ----- | ----- |
| <i>LuchengRn-CoV</i> | ----- | ----- | ----- | ----- | LV | VK | Q | AV | V | Q | R | P | IR |
| <i>Mink-CoV</i> | ----- | ----- | ----- | ----- | VL | IS | NG | Y | T | P | V | V | Q |
| <i>NL63</i> | ----- | ----- | ----- | ----- | I | V | V | G | C | V | T | S | N |
| <i>NL63-related</i> | ----- | ----- | ----- | ----- | V | V | V | A | G | G | M | A | R |
| <i>Porcine-EDV</i> | ----- | ----- | ----- | ----- | V | V | S | E | Q | T | A | V | --- |
| <i>TGE</i> | ----- | ----- | ----- | ----- | AIAS | NFV-V | KK | Q | A | E | E | R | P |
| | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | FNKV |



3180 3190 3200 3210 3220 3230 3240 3250 3260 3270 3280 3290 3300

Bat-BCoV -----VTIIPAPKNADAPVLIESLTTDDALAMYVKGTRDFVVKANSLSKLFGINTEIQNGVDALNMCYDRLAVFDYVVKPFLT-----VTKTASD-VTIKAGKVACS-----L

Bovine-CoV VKKPFKVEDSVIIVNDTSEIKYVKSLSIVDVYDMWLTG-CRYVVRTANALSMVNVPTIRKFIKFGMTLV-----SIPID-LLNLREIK-----PVFNV-----VKAVRNKISA

Covid-19 VKTTEVVGDIILKPAAN-SLKITEVGHDTLMAAYVDN-SSLTIKKPNELSRVLGLKTLATHGLAAVNSV-PWDTIANYAKPFLN-----KVVSTTT-NI--VTRCLNR-----V

GCCDC1 LTAPIVLDGVNYVPGKGDLLCLKEFTIIDLKTFFYVEGNQPFVLLKENHLSKLLGLKISSNKLTV--NKI-SSALILSYGLSLKSACAVKCATKKTLLRYGAQATA-NCIRETKPGA-----K

HKU1 VRKTVKIEDAIIIVNDENSSIKVVKSLSLVDVDMWLTG-CDYVVWVANELSRLVKSPTVREYIRYGKPI-----TIPID-LLCLRDDN-----QTLLV-----PKIFKARAIE

HKU14 VKKPFKVENSVVNDSTSETKFKVKSLSIVDVYDMWLTG-SRYVVRTANALSAVNVPTIKKFIKFGMTLV-----SIPID-LLNLREIK-----PVFGA-----AKVVRDRVSD

HKU24 VKKPISVDGVIIENDDKAEATLVKSLTLDVIAWWTG-GRYVVWVANWLSKLVCTPTVREYVVKRGLQKV-----KIPVE-LFSRRDK-----CDVV-----QKSIKRVVLA

HKU4 LNKPFVKGNFSFVNDPN-GVTVVDTLGLTELRALYVDINTRYIVLRDNWSSFLKLTVESGDLQIVAA--GGSVTRRARVLLGASS--LFASFAKITVTATTAACKTAGRGFCFVVNYGVLQN

HKU5 LKKPFVKDGYSFVNDPQ-GVNVIDTLGIDDLRALYVDRNLRLLIVKENNSALFNHITVEKGDLSVIAA--SGSITRRVKILLGASS--LFAQFASVTVNVTTAMGKALGRMTRNVITNTGIIGQ

HKU9 LKATMVLNGTTYVPGNKGHLLCLKEFTLTDLQTFYVEGVQPFVLLKASHLSKVLGLRVSDSSLHV--NHL-SKGVVYAYAATRLTTRVTSLLGGLVTRSVRKTA-DFVRSTNPGS-----K

Hedgehog-CoV LSKPFVKNGFSFISDDK-GILTVEYLTKEDMHTLYVNPKSQIIIVLKDNLWLSGLFQMHTVQSGDLNVVAS--SGSLTKVKVLLFKTSS--MCKEFLSRTFVATKCVNSVVSATVRKLCCKNDVFK

MERS-CoV LNKPFVKDNVSVFVADDGTPVVEYLSKEDLHTLYVDPKYQVIVLKDNLVSSMLRLHTVESGDINVAS--SGSLTRKVKLLFRASF--YFKEFATRFTTATTAVGSCIKSVVRHLGVTGILTG

MHV VKKPVKVEGSVVNDPTSETKVVKSLSIVDVYDMFLTG-CKYVVWTANELSRVNSPTVREYVVKWGMKI-----VTPAK-LLLLRDEK-----QEFVA-----PKVVKAKAIA

OC43 VKKPFKVEDSVIIVNDTSETKYVKSLSIVDVYDMWLTG-CKYVVRTANALSRVNVPTIRKFIKFGMTLV-----SIPID-LLNLREIK-----PAVNV-----VKAVRNKISV

Rat-CoV VKKPVKVEDSVVNDPTSDTKVVKSLSIVD--DMFLTG-CKYVVWTANELSRVNSPTVREYVVKW--KI-----VIPTK-LLLLRDER-----QEFVA-----PKVVKAKAIA

SARS-CoV VKTTEVVGNVILKPSDE-GVKVTOELGHEDLMAAYVEN-TSITIKKPNELSLALGLKTIATHGIAAINSV-PWSKILAYVKPFLG-----OAAITTS-NC--AKRLAOR-----V

229E -----TVKPKPVISQL-----DENAQKFFDFGD-----FL-----VHN

Bat-CoV-1A -----NNTPVKIIKKL-----DDASEKFFSFGD-----IV-----SKN

BtCoV512 -----VKR-----VELDASKFLDTM-----NVASEKFFTFGD-----FV-----SRN

BtMr-AlphaCoV -----MP-----KKIKLDRVMTDL-----DNGAKKFFDFGD-----FI-----LRN

BtNv-AlphaCoV -----TVS-----SGDAPLDLSTTL-----NTAASKFFSVGD-----VV-----ARN

BtRf-AlphaCoV -----AKPKIAEVMNKL-----DNASEKFFSFGD-----VV-----SRN

CDPHE15 -----VKS-----FEQRASAVVDSL-----NFASEKFFTFGD-----FV-----SRN

FCoV -----EENPKNIVR-----KEKLLAIESGVDYITITTL-----GKYADVFFMAGD-----KI-----LRF

Ferret-CoV -----APSVPK-----S--ASN--SKPDTMQKL-----DEYANMFFSFGD-----TL-----LKF

HKU10 -----VEREASSIVNTL-----DTSAEKFFSFGD-----IV-----SRN

HKU2 -----KTEHVPLIKKL-----DSSAEKFFNVGD-----IV-----AHN

HKU8 -----AKS-----SEPTAVKIMSKL-----DDASDKFFTAGD-----VV-----SHN

LuchengRn-CoV -----VVA-----KPQPVKPPIDYVKKF-----EDFSVRFFSVGD-----YI-----FGN

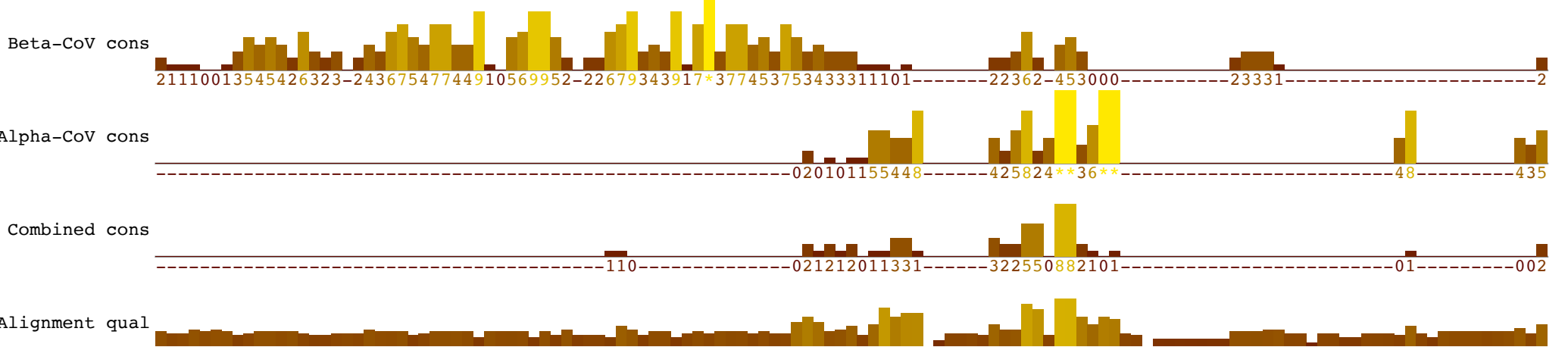
Mink-CoV -----SPRITR-----D--LQVVDNDLDAIQKL-----DKYANKFFKFGD-----TV-----AKT

NL63 -----IVSEKISVMDKL-----DTGAQKFFQFGD-----FV-----MNN

NL63-related -----PVQHKKSVMEKF-----DVSAQNFFRFGD-----FV-----MNN

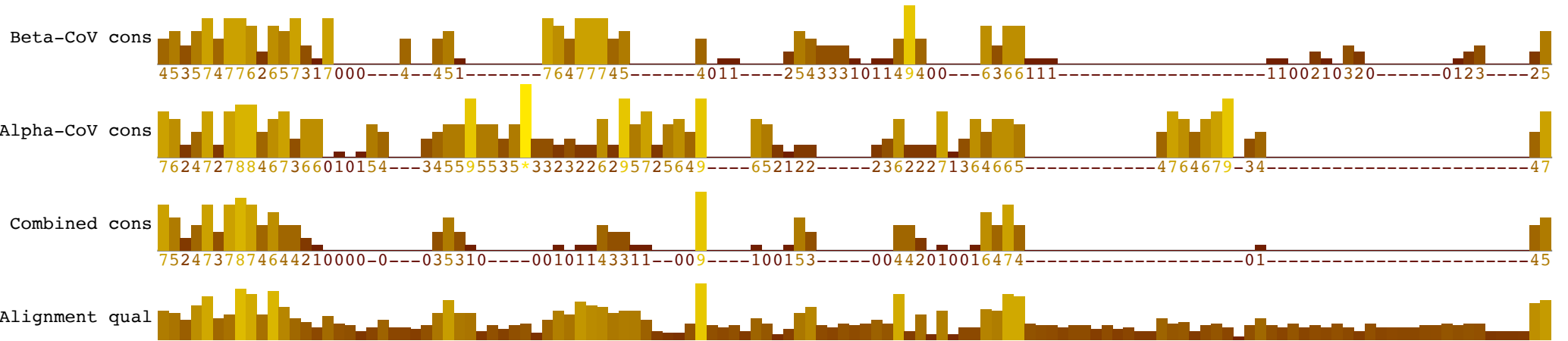
Porcine-EDV -----VKK-----AELDATKLLDTM-----NYASERFFSFGD-----FM-----SRN

TGE -----AA-SPKIVO-----EOKLLAIESGANYALTEF-----GRYADMFFMAGD-----KI-----LRL

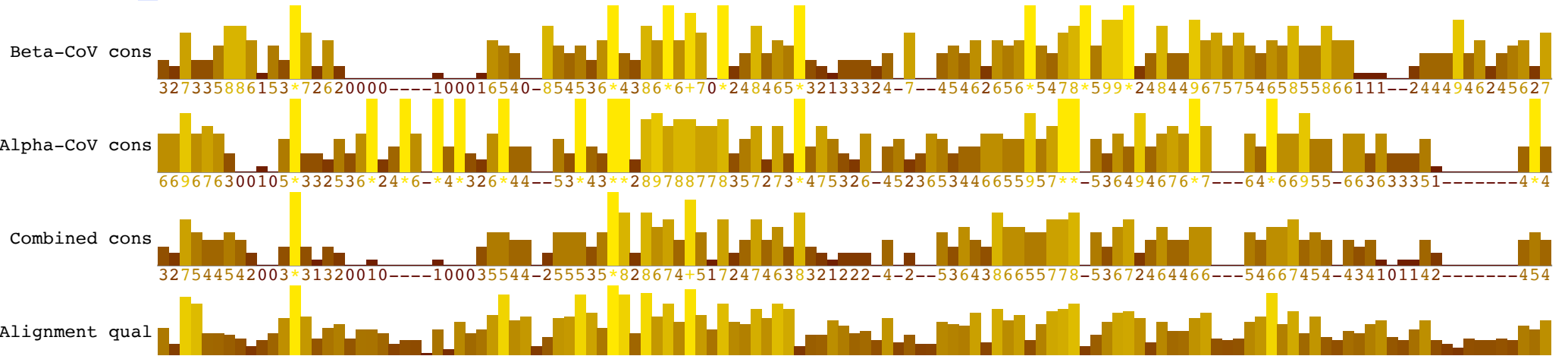


310 320 330 340 350 360 370 380 390 400 410 420

Bat-BCoV LQRTVPLLYALVVSYLVPFLTRTKQRVSVK----VPMVLTKNKTCRSVFLGMLMNGVANYFTSP---KFK---SCVRVF---ALATCIAAILYMAMF-VYLFFDIWLSKA-----NVWT----DV
Bovine-CoV CFNFIKWLFLVLLFGWIKIS-ADN--KVI-----YTTEVASKLTC---KLVA---LAFKNAFLTFKWSVVARGACIIATIFLLWF-----NFIYANVIFSDFYLPKIGFLPTFVGKIA
Covid-19 CTNYMPYFFTLTLLQ-LCTFTRSTNSRIKAS-----MPTTIKNTVKSVMGKFCLEASFNYLKSP---NFS---KLINI I WFLLLSVCLGSLIYS-----TA----AL
GCCDC1 IVGILCMFYRVLLHLW----FAIKKPLVK-----VSGIVAYNTGCSVTA---CVFNYLKRFSNNTSWTGISRVLRLLLYMWFWTCL-----AIVGVVWSEP-----YAPS---LL
HKU1 FYGFLKWLFIYVFSLLHFT-NDK--TIF-----YTTEIASKFTF---NLFC---LALKNAFQTFRWSIFIKGFLVAVTFVFLWF-----NFLYINVIFSDFYLPNISVFPFVGRIV
HKU14 CYRFIKWLFLVLLFGWIKIS-SYN--RVV-----YTTEIASKLTC---KLVA---LAVKNALLTFKWSMVVRGFFLIATIFLLWF-----NFIYANVIFSDFYLPKIGFLPTFVGSV
HKU24 PMNALRLFYVLMCSWLKPK-SDN--KVV-----YTTEIVSKFSS---KLFV---KACGIALRNFKWMGLLRGFFVATIFLLWF-----SVIFANVIFSDLYLPNIRFMPPLVGHVI
HKU4 MFVFLKMLFFLPFNLYLWPK---KQPTVDIGVSGLRTAGIVTTN---IVKQCCTAAYMLLKGFKRVDWKAT---LRLFLLL---CTTILLSSIYHLVFNQVLS SDVMLEDATGILA----IY
HKU5 GFALLKMLLILPFTFWKSK---NQSTVKVEVGALRTAGIVTTN---VVKQCASAAYDVLVVKFKRIDWKST---LRLFLI---CTTGLLLSSLYLFLFHQVLTSDVMLDGAEGMLA----TY
HKU9 CVGLLCLFYQLFMRFW----LLVKKPIVK-----VSGI IAYNTGCGVTT---CVLNYLRSRCGNISWSRLLKLLRYMLYIWFVWTCL-----TICGVWSEP-----YAPS---LV
Hedgehog-CoV LFSFIKMLCFIPLRHFNKQ--K-ECVNVVDVKTL SIAGVVGTN---VIKQCSTGFYLFKQKLRIDWKSS---LRWLLFM---LTTVLMLLSLYHLYVFNVAULTSDVIKEVNTGIK---VY
MERS-CoV CFSFAKMLFMLPLAYFSDS---KLGTEVVKVSAKTAGVVGTN---VVKQCCTAAYDLSMDKLRVDWKST---LRLLLML---CTTMVLLSSVYHLYVFNQVLS SDVMFEDAQGLK---FY
MHV CYCAVKWFLLYCFSWIKFN-TDN--KVI-----YTTEVASKLTF---KLCC---LAFKNALQTFNWSVSRGFFLVATVFLWF-----NFLYANVILSDFYLPNIGPLPTFVGQIV
OC43 CFNFIKWLFLVLLFGWIKIS-ADN--KVI-----YTTEIASKLTC---KLVA---LAFKNAFLTFKWSMVARGACIIATIFLLWF-----NFIYANVIFSDFYLPKIGFLPTFVGKIA
Rat-CoV CYGAVKWWFFYCFSWIKFN-TDN--KVI-----YTTEIASKLTF---KLCC---LAFKNALQTFNWSVSRGFFLVATVFLWF-----NFLYANVILSDFYLPNIGSLPTFVGQIV
SARS-CoV FNNYMPYVFTLLFO-LCTFTKSTNSRIRAS----LPTTIKNSVSKVAKLCLDAGINVYKSP---KFS---KLFITAMWLLLSICLGLSICV-----TA----AF
229E FVIFFTWLLSMFTLCKTAVTT---CDVKIMAKAPQRTGVVLRSLKYNLK---ASAAVL---KSKWLLAKFTKLL---LLIYTLY-SV-----VL
Bat-CoV-1a VCNSIIWFFTMLSIIIFRAFKT---RDFKVFALAPERTGVILSRSLKYNLK---AAQHV---RRKQTYVERFFKFS-----VIAYTLY-AL-----SF
BtCoV512 IIVLIVYLFSLLAICFRALKK---RDMKVMAGVPERTGIIILKRSVKYNYK---ALKFFF---RLKFQYIKVFLKFS---LVLYTLY-AL-----MF
BtMr-AlphaCoV LASFFSIFFSLLFVGYKALKK---RDVKVLAQAPQRTGIIILTRSLKYNCK---AAFKFW---QTRSWCIIMLFKII---LLLFALF-AA-----CF
BtNv-AlphaCoV VGMFCVWLFMSMLTLFKTFFK---RDFSVALAPQRTGVIFRSLKYNCK---AAYKHL---NSKWGTVKFVMKLL---VMFYTLY-ML-----LF
BtRf-AlphaCoV FAAVFVWLFMSMIGLVFKAFKT---KDVKVFALAPERTGIIILGRSIIKYNFK---ATKQLL---VSKIKWVKLFGKIL---LAMFAIY-AT-----SF
CDPHE15 VITMLVWFFSLLSLLKSVRR---RDFRVLAGAPERSGVIISRSIIKYNVR---ALRYFM---RLKAKWVCMFLKAC---FILIYTCY-AT-----CF
FCoV LLEVFKYLLVVMFCL---RKS---KMPKVVKVPPH---VFRNLGAKVR---TLNVVR---QLNKPALWRYIKLV---LLLIALLY-HF-----FY
Ferret-CoV CVTIFKYLLCFYFFFLERCTKS---KRLKVKIKPPF---ALKPLDVKLR---ALNSVK---LLTNTKFWFYIKFL---LGLLLLY-NL-----LY
HKU10 CVTFLVWLFMSFSLAFKAFRT---RDVKVIAQVPQRTGLILSRSLKYNVK---ATNKFL---QSRTKWVVLFSKML---LVLSTLY-AL-----WF
HKU2 IAYFFVWLLTTLSTLYRCWRG---GNFKLLSSIPERSGIVLRRSFKYNFR---ALRSNV---ASKQYCLMFAKLL---LLLYTIY-AM-----LF
HKU8 IANSVWFFTMLSILFKAFKT---RDFKVFALAPERTGIIIFTRSLKYNIK---AARDML---KRRQKWFVFLKFC---LLLYTAY-AV-----LF
LuchengRn-CoV LTIFFMMLDVFKTCLTSLRK---RDIKILARIPKRSGLVFTKSLLYNSK---VAASGI---YAKRRWFYIFGIVA---SAFYIGY-SL-----LF
Mink-CoV ILAVFKYLLCCYFFLLENCTKS---KCLKVKVKKPPF---VVKPLDVKLR---ALNSIT---LLTNTKFWFYIKFL---LGLLLLY-NL-----LY
NL63 IVLFLTWLLSMFSLLRSTSIMK---HDIKVIAKAPKRTGVILTRSFYINIR---SALFVI---KQKWCIVITLTKFL---LLLYAIY-AL-----VF
NL63-related FILFLTWLFMSMLSLRSTSIK---RDVKVIAMAPRRTGIIILTRSLKYNVK---SATVVA---KQKWCYISMLLKV---LLLYTMY-AS-----IF
Porcine-EDV LITVFLYILSILGLCFRAF RK---RDVKVLAGVPQRTGIIILRKSRYNAK---ALGVFF---KLKLYWFKVLGKFS---LGIYALY-AL-----LF
TGE LLEVFKYLLVLFMCL---RST---KMPKVVKVPP---AFKDFGAKVR---TLNYMR---QLNKPSVWRYAKLV---LLLIAYI-NF-----FY



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Bat-BCoV QTLKDNFGLGTVCDKFQTAYNNSGIYDATEYCTGKSFMCSLCLRGMDSLNFYTELSTSQKTVSWSSF-D--FSNINTAAEFWCLAYLLYTKMFVVLATAIFQWFAVYFGLYL--TQSSWLMWMTMVRV
Bovine-CoV QWIKSTFSLVTICDLYSIQDV----GFKNQYCNG--SIACQFCLAGFDMLDNYKAIDVVQYEADRRAFVD--YTGVLKIVIELIVSYALYTAWFYPLFALISIQILTTWLPPELFMLSTLHWSVRLVLSL
Covid-19 GVLMSNLGMPSYCTGYREGYLNSTNVTIATYCTG--SIPC SVCLSGLDLSDTYPSLETIQITISSFKW-D--LTAFLGLVAEFWFLAYILFTRFFYVPLGLAAIMLFFSYFAVHF--ISNSWLMWLIINL
GCCDC1 TKVKYQYFGVFPDYL-----VNETSEGWFFHMCMSGMDGLD--YPALMQORR--YGSPY-D--WTYVMVFLFAFVAYLLYTPVPLVGIIGCLHALVLYLPIIS---LGNWLVVFFYYF
HKU1 MWIKATFGLVTICDFYSKLGV----GFTSHFCNG--SFICELCHSGFDMLDYYAIDFVQYEVDRRVLFD--YVSLVKLIVELVIGYSLYTVWFYPLFCLIGLQLFTTWLPDLFMLETMHWRIRFIVFV
HKU14 QWLKTFGFYTLCDFYDTASI----GFKNQYCNG--SLACQLCVSGFDMLDNYKAIDVVQYEADRRSVVD--YTGMIKLI IELVVSALYTAWFYPLFGLICLQMLTTWLPPEFFMVSSLHWFRLILVSV
HKU24 ARLKFIQGFWTLCDSIDVSSI----GFTFDNCT--SVACQFCLSGFDMLDNYKAIDFVQYHVAGFSGFD--YKSFVAVLVELVISVLYTVWFYPLFGLVCLQIFTTWFPDMFMITELHWFVRLFLYM
HKU4 KEVRSYLGIRTLCDGLVVEYRNTS--FDVMEFCSNRSVLCQWCLIGQDSLTRYSAIQMLQTHITSYVL-N--IDWIWFALEFFLAVLYTSSFNVLLLVVTAQYFFAYTSAFVNWRAYNYIVSGLFFL
HKU5 RELRSYLGIIHSLCDGMVEAYRNVS--YDVNDFCNRSALCNWCLIGQDSLTRYSAIQMLQTHITSYVL-N--IDWVWFVMEFALAYVLYTSTFNVLLLVVSSQYFFSYTGAFVNWRAYNYIVSGLFFL
HKU9 TRFKYFLGIVMPCDYVL-----VNETGTGWLHHLCMAGMSLD--YPALRMOHR--YGSPY-N--YTYILMLLEAFFAYLLYTPALPIVIGILAVLHLLVLYLPIIP---LGNWLVVFLYYI
Hedgehog-CoV YRISSYLGVTSCDGFSSNNYRNVS--FNRDDYCEKFGYVCHWCLMGQDSLTHYSAIQVQTNLSHYVL-S--IDWMMFWIELSVAYLMYTPAFNWLVLVCTLYQYFFSQTNHIINWRSYNFVMSGVYLL
MERS-CoV KEVRAYLGISSACDGLASAYRANS--FDVPTFCANRSAMCNWCLISQDSITHYPALKMVQTHLSHYVL-N--IDWLWFAFETGLAYMLYTSAFNWL LLAGTLHYFFAQTSIFVDWRSYNYAVSSAFWL
MHV AWFKTTFGVSTICDFYQVTDL----GYRSSFCNG--SMVCELCSGFDMLDNYDAINVQHVVDRLSFD--YISLFLKLVVLELVIGYSLYTVCFYPLFVLIQMLLTTWLPPEFFMLETMHWSARLFVYV
OC43 QWIKNTFSLVTICDLYSIQDV----GFKNQYCNG--SIACQFCLAGFDMLDNYKAIDVVQYEADRRAFVD--YTGVLKIVIELIVSYALYTAWFYPLFALISIQILTTWLPPELFMLSTLHWSFRLVAL
Rat-CoV AWFKTTFGVSTICDFYQVTDL----GYRSSFCNG--SMVCELCSGFDMLDNYDAINVQHVVDRLSFD--YISLFLKLVVLELVIGYSLYTVCFYPLFVLIQMLLTTWLPPEFFMLETMHWSARLFVYV
SARS-CoV GVLLSNFGAPSYCNGVRELYLNSSNVTMTDFCEG--SFPCSI CLSGLDLSYPALETOVTISSYKL-D--LTILGLAAEFWVLAFLYMLFTKFFYLLGLSAIMQLVFFGFASHF--ISNSWLMWFIISI
229E FCVRFGPFE--FCSETVNGYAKSN--FVKDDYCDG--SLGCKMCLFGYQELSQFSLD VVWKHITDP--LFSNIQPFIVMVL LLIIFG--DNYLRCFLLYF----VAQMISTV--GVFLGYKET-----NWF
Bat-CoV-1A MFVRFSPANDYFCCKDHVEGYSNST--FVKDEYCAS--TMCKVCLLGFQELADLPHTKVVWKYVGF--IFVNWLPFLYLAF LFTFG--GIFVKGLVCYF----FAQYVNTL--GVYFGMQEK-----FWP
BtCoV512 MFIRFPTVGTPICKRYTDGYANST--FDKNDYCGN--VLCKICLYGYEELSDFTHTRVIWQHLKDP--LIGNILPLFYLVLIIIFG--GFFVRIGITYF----IMQYINAA--GVALGYQDN-----VWL
BtMr-AlphaCoV MLIRFSFLNKYFCGYVAGYANST--FVKKDFCNG--GLVCDACLHGFDQLSDFSHLNKWDYITVP--FALKVYPSVAVLFLFLFG--GVYVKFMMLYV----LAQYVNTL--GVYFGFQDY-----FWV
BtNv-AlphaCoV LTVRFSPNLNVFCDYVDGYANST--FVKSDFYCDG--LVCKCLYGYQELSDFPDLDTWEIFTHP--LLVSEMPLLYMAFLLCFG--NKWVRFLMICYF----ILQYVNAA--GVVLGLQDS-----IWA
BtRf-AlphaCoV MLVRFGLPNESTCTDYVKNYSESN--FNKAAYCDG--ITCKTCLYGYQELSDFPHTSTVWEHVKDP--LFFKVMPMFYMAFLLIIFG--GTITRSCMLYF----LAQYVNNI--GVFLGVQDN-----VWA
CDPHE15 MIIRFSFVSDIFCSGYVDGYANSS--FDKNAYCDG--QLCKVCLFGYDELADFPHTTVVWEHLKDP--FVINVIPLFYLGLFAIFG--GTVTRIMVLYF----VSQYVNNL--GAYLGVQDS-----VWF
FCoV LFSVSPVHKLACSGSVQAYSNS--FVKSEVCGN--SILCKACLASYDELADFDHLQVSWDYKSDP--LWNRVIQLSYFIFLAVFG--NNYVRCLLMYF----VSQYLNW--LSYFGYVKY-----SWF
Ferret-CoV VIVSVPIHRFACASYTKAYANSS--FVKADVCTR--SVLCKACLASYEELSDFDNLKVIWQYKSDP--LWSKMLQLVYFGALMVFG--NNVLRVAMLYF----VAQCLNTW--FSYYGLVNY-----SWL
HKU10 LLLRFGPLHDTVCTSYVEGYSKSN--FDKNAFCEN--LACKTCLYGYEELSDFPHTVTTWTHLGD--LFTLLPLIYIAFLIIFG--GVVVRGFMLYF----VAQYVNF--GVVLGFQDS-----VWA
HKU2 ILVRFSSFNDIYICGSAVRGYASSD--FDKSKFCNG--SLVCKTCLYGYEELSDFPHTVTVVWVSYVREP--LFAVPLCYFAVIAIFG--GVVERFALCYF----AAQFINNV--LSFLKLQDS-----FWL
HKU8 MFIRFGPPNETLCKDHVDGYANST--FVKDDYCN--ALCRVCLFGYQELADLPHTN VVWRHVGMP--LFSVNWMLPFLYLAFLIFG--GFVTKGFVLYF----VAQYVNAF--GVHFGMDL-----FWP
LuchengRn-CoV TTLRFSS----LCKGWTGYANST--FIKQDYCNG--SLICYECLRGYEELSDFPHTQVKSFTYNSLSEFALFYHVLFTFTIMVWFG--NKYVKALLFYF----VLQWNSA--MCWFDETEP-----IWF
Mink-CoV VVSVPLFHKVACSRYSSMYANSS--FVKSDVCSS--SVLCKACLSSYEELSDFDHLRVVWQYKSDP--LWYKLVQLFYFGTLMIFG--NNIVRFCMLYF----VAQLFNNW--LSYYGLVNY-----SWF
NL63 MIVQFSPFNLLCGDIVSGYEKST--FNKDIYCGN--SMVCKMCLFSYQEFNDLDTSLVWKHIRDP--LISLQPFVILVILLIFG--NMYLRFGLLYF----VAQFISTF--GSFLGFHQK-----QWF
NL63-related MVVQLNPNFNSLFCSDTISGYENST--FDKDVYCGK--SMCRMCLFGYQELSDLEHTSVIWKHIRDP--LILAGLQPFVILVILLIFG--NMYLRFGLLYF----VAQFISTF--GSFVGFHQK-----QWF
Porcine-EDV MTIREFTPIGSPVCDVAGYANSS--FDKNEYCNS--VICKVCLYGYEELSDFSHTQVWVQHLRDP--LIGNVMPFFYLAFIAIFG--GVVKAITLYF----IFQYLNLSL--GVFLGLQDS-----IWF
TGE LFSVSPVHKLTCNGAVQAYKNSS--FIKSAVCGN--SILCKACLASYDELADFOHLOVTWDFKSDP--LWNRVLVOLSIFYAFLAVFG--NNYVRCFLMYF----VSQYLNW--LSYFGYVEY-----SWF



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Bat-BCoV ISLVPTSILVRMYIYCASFYFVYRAYVHVVSVCQDTRCLMCKYRNLRARRVECHTVVQGRSKSFYVHANGGT-GFCEKHAWNCINCDSYGPGNTFICDEVAVDLSTTFKRPVKPTDKSHYFVDSVEVK

Bovine-CoV ANMLPAHVFMRFYIIASFIKLFLFRHVAYGCSKPGCLFCYKRNRSRVRVKCSTIVGGMIRYYDVMANGGT-GFCSKHQWNCIDCDSYKPGNTFITVEAALDLSKELKRPVQPTDVAYHTVTDVKQV

Covid-19 VQMAPISAMVRMYIFFASFYVWKSYPVHVVDGNSSTCMCKYRNRRATRVECTIIVNGVRRSFYVYANGGK-GFCKLHNWNCVNDTCFAGSTFISDEVARDLAQLFKRPIINHTDEAYEYVTSVQVR

GCCDC1 VKLIPLSLLRMYIVSAFLWLKCYKGFVHVRYGCTNVSCLMCKYRNRIATRVECTVNVGVRRSFYVYANGGT-YYCTKHNWNCVNDTYIVDSTFISRPVALDLAQLFKRPIINHTDEAYEYVTSVQVR

HKU1 ANMLPAFVLLRFYIVVTAMYKVVGFIRHIVYGCNKAGCLFCYKRNCSVRVKCSTIVGGVIRYYDITANGGT-GFCVKHQWNCFNCHSFKPGNTFITVEAAIELSKELKRPVNPVDASHYVVTDIKQV

HKU14 ANLLPAHVFLRFYITVTFIFKIFSLFRHVIHGCKNAGCLFCYKRNRSRVRVKCSTVGGMIRYYDVMANGGT-GFCSKHQWNCINCDSYKPGNTFITVEAAAELSKELRRPVVPTDVAYHTVTDVKQV

HKU24 ANLLPFHVFLRLYIIVVFIKMFKLFVRHVHGCNKPGCLFCYKRNKSVRVRVKCSTVGGMLRYYDVMANGGI-NFCNKHQWNCIGCDSYKPGNTFITVEAAAELSKFKRPIINPTDVTHYVVECVQV

HKU4 VTHIPLHGLVRVYNFLACLWFLRFYSHVINGCKDTACLLCYKRNRLTRVEASTIVCGTKRTFYIAANGGT-SYCKHNWNCVCDTAGVGNFTFICTEVANDLTTTLRRLIKPTDQSHYVVDVSVVK

HKU5 VTHIPLGLVRIYNFLACLWFLRFYNHVINGCKDTACLLCYKRNRLTRVEASTIVCGSKRTFYIVANGGT-SFCRHNWNCVCDTAGIINTFICEVANDLTTSLRRLVKPTDKSHYVVESVTVK

HKU9 IRLVPFTSMLRMYIVIAFLWLKCYKGFVHVRYGCTNVACLMCKYKKNVAKRIECSTVNVGVKRMFYVYANGGT-HFCTKHNWNCVCDTYIVDSTFICROVALDLAQLFKRPIIHTDEAYEYVTSVEVR

Hedgehog-CoV TTYIPLCGLLRVYNVLAATLWYLRRFYNHVINGCKDTACMLCYKRNRLTRVEASTVCGVKRTFYITANGGI-SFCSRHNWNCVCDTGLGHTFICEEVANDLTTSLRRLVKPTDRSHYVVESVEVK

MERS-CoV FTHIPMAGLVRMYNLLACLWLLRFYQHVINGCKDTACLLCYKRNRLTRVEASTVCGKRTFYITANGGI-SFCRHNWNCVCDTAGVGNFTFICEEVANDLTTALRRPINATDRSHYVVDVSVTVK

MHV ANMLPAFTLLRFYIVVTAMYKVYCLCRHVMYGCSPGCLFCYKRNRSRVRVKCSTVGGSLRYYDVMANGGT-GFCTKHQWNCINCDSYKPGNTFITHEAAADLSKELKRPVNPDSAYYSVTEVKQV

OC43 ANMLPAHVFMRFYIIASFIKLFLFRHVAYGCSKSGCLFCYKRNRSRVRVKCSTIVGGMIRYYDVMANGGT-GFCSKHQWNCIDCDSYKPGNTFITVEAALDLSKELKRPVQPTDVAYHTVTDVKQV

Rat-CoV ANMLPAFTLLRFYIVVTAMYKVYCLCRHVMYGCSPGCLFCYKRNRSRVRVKCSTVGGSLRYYDVMANGGT-GFCTKHQWNCINCDSWKPGNTFITLEAAADLSKELKRPVNPDSAYYSVTEVKQV

SARS-CoV VQMAPVSAMVRMYIFFASFYVWKSYPVHVIMDGTSSTCMCKYRNRRATRVECTIIVNGMKRSFYVYANGGR-GFCKLHNWNCVNDTCFAGSTFISDEVARDLAQLFKRPIINHTDEAYEYVTSVQVR

229E LHFIPFDVICDELFTVIVIKVISFVRHVLFGCENPDCIACSKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

Bat-CoV-1A LQIIPFDIFGDEIVVTFIVYKALMFIKHVCFGCEKPCVACSKSARLNRVPMQTIIVGANKLFYVANGGS-SYCHKHFFCLNCDSYGPGNTFINETVARELSNVVKTNVQPTGESFIEVDKVSFE

BtCoV512 LHLLPFNSMGNIIVVAFIVTRILLFLKHVLFVFGCDKPCSIACSKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

BtMr-AlphaCoV VHIIPFDVFCDEILAIFCAVKGLLFLKHVIMGCDSPSCIACSKSARLRRVPMQTIIVGANKLFYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

BtNv-AlphaCoV LHLVPFDIFGDEIVVWLVYVILAFVFLKHVCFGCEKPCVACSKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

BtRf-AlphaCoV LQFVPFDVFGDEIVVIFLVVKILLFAKIVFVFGCDKPCVACTKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

CDPHE15 LQFVPFDVFGDEIVVIFLVVRLMFLKHVLFVFGCDKPCVACTKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

FCoV LHVVNFESISVEFVIVVVFKAVLALKHIFLPCNNPCKTCSKIARQTRIPVQVNVGSMKTVYVHANGTG-KLCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

Ferret-CoV LHIVNFETVAEIVVLMVVVKGFFFLKHVYWGCDKASCSCSKTAKQKRIIPVSVIVGSMKTIYVHTNGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

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HKU8 LHLLPFSTFGDEMVLVGRFLMFKHVCFGCDKASCVACSKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

LuchengRn-CoV LNFIFKSSISAHGSLFCVFKIACFKHVVFVGCNDVKCLSCSRSAKYDRISCDTIVNGVKSRYVYKANGGK-SFCEKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

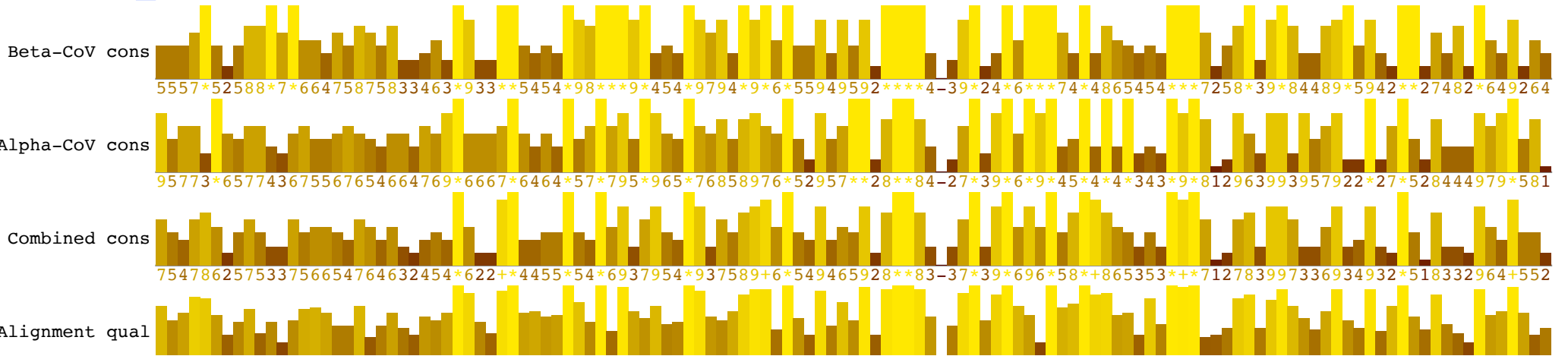
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NL63 LHFVPFDVLCNEFLATFIVCKIVLVRHIIIVGCNADCVACSKSARLKRVPLOTIINGMHSFYVYVANGGT-CFCNKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

NL63-related LHLVPFDVLCNEFLATFVVKIVLFAHIIIVGCNADCVACSKSARLKRVPLOTIINGMHSFYVYVANGGT-HFCNKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

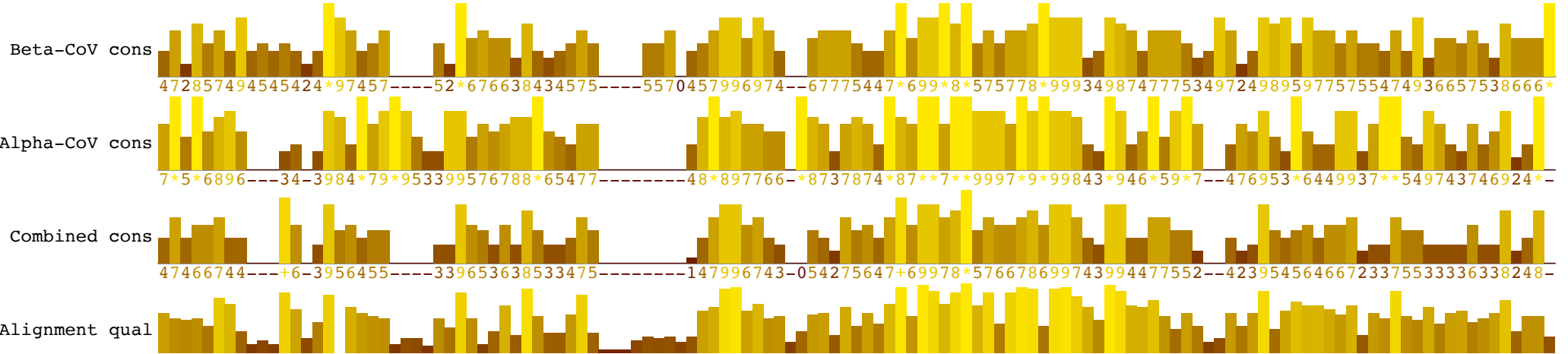
Porcine-EDV LQFVPFDVFGDEIVVIFLVVVKILLFAKIVFVFGCDKPCVACTKSARLKRFPVNTIVNGVQRLFVYVANGGS-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

TGE LHVVNFESISAEFVIVVIVKAVLALKHIVFACSNPCKTCSRTAROTRIPVQVNVGSMKTVYVHANGTG-KFCKKHFFCVDCDSYGYGSTFITPEVSRELGNITKTNVQPTGPAYVMDKVEFE

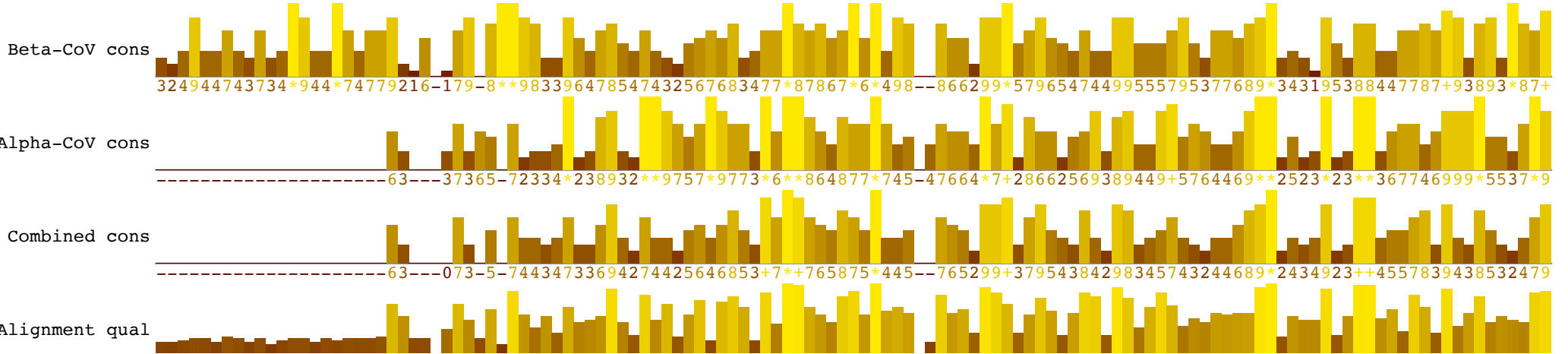


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Bat-BCoV DTFVHLIYYSKNDTRVYDRYPL----SVFSSVDFLKLANK---TMPSS--TNVLVFDASNKTEENTTVAASVYYSQLCCQPMLLIEQKLLSNIGDATEVSKKMLDAYIEKFMSTFGVTMEKLTFFVSAA
Bovine-CoV GCMRFLFYERDGRQTYDDVNA----SLFVDYSNLLHSHKVK---GVPNMHVVVVEND--ADKANFLNAAVFYAQSLFRPILMVDKNLITANTGTSVETEMFDVYVDTFLSMFDVDDKSLNALIATA
Covid-19 NGSIHLYFDKAGQKTYERHSL----SHFVNLDNLRANNTK---GSLP--INVIVFDGKSKCEESSAKSASVYYSQLMCOPIILLDQALVSDVGDSEAEVAKMFDAYVDTFSLSTFNVPMEKLTFLVATA
GCCDC1 NGYVVCYFDSSEGEQSYERFPV----DSFTNVSKLYYSELK---GNPPAFNVLIFDATTNRIEENAVKTAAIYYAQLACKPILLVDKRMVGVVGGDDTAIARAKMFEAYAQNYLLKYSIAMDKVKHLYSTA
HKU1 GCMRFLFYDRDGRQVYDDVDA----SLFVDINNLLHSHKVK---VVPNLYVVVVESD--ADRANFLNAVVFYAQSLYRPIILLVDKLIITACNGISVQTQTFMDVYVDTFMSHFVDVDRKSFNNFVNIA
HKU14 GCMRFLFYDRDGRQVYDDVNA----SLFVDYNNLLHSHKVK---SVPNLHVVVVEND--ADKANFLNAAVFYAQSLFRPVLMDVSKSLITANTGTSVSTQTFMDVYVDTLLSMFDVDRKSLTSFINTA
HKU24 GCMRFLFYEKDGRQVYDDVNA----SMFVDFNGLLHSHKVN---GVPKTNVVIIVDGD--ADKANFLNAVVFYAQSLFRPVLMDKSLITASTGTNVSKTMDVYVDTLLGMFEVERKSLNNFIQVA
HKU4 DAVVELHYNRDGSSCYERYPL----CYFTNLEKLFKEVCKTPTGPIEHNFLIYDSDRGQENLARSACVYYSQVLCCKPMLLDVNLVTTVGDSTREIAIKMLDSFINSFISLFSVSRDKLEKLINTA
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HKU9 NGYVVCYFESDGRQSYERFPM----DAFTNVSKLHYSELK---GAAPAFNVLVFDATTNRIEENAVKTAAIYYAQLACKPILLVDKRMVGVVGGDDTAIARAKMFEAYAQNYLLKYSIAMDKVKHLYSTA
Hedgehog-CoV NSVVQLNYTRDGLCYERVPL----CNFSNIDKFKFKEVCKSTTGPIEFNFVIYDSDRGQENLARSACVYYSQVLCCKSILLVDSNLMNTVGDSSAIAIRLLDSFINSFASLYNVSRDKLEKLISTA
MERS-CoV ETVVQFNYYRRDGRQPFYERFPL----CAFTNLDKLFKEVCKTTTGPIEYNFIIYDSDRGQESLARSACVYYSQVLCCKSILLVDSLVTSVGDSSAIAIRLLDSFINSFASLYNVSRDKLEKLISTA
MHV GCMRFLFYERDGRQVYDDVNA----SLFVDMNGLLHSHKVK---GVPETHVVVVENE--ADKAGFLGAAVFYAQSLYRPEMLMVEKLIITANTGLSVSRQTFMDLYVDSLNLVLDVDRKSLTSFVNAA
OC43 GCMRFLFYDRDGRQTYDDVNA----SLFVDYSNLLHSHKVK---SVPNMHVVVVEND--ADKANFLNAAVFYAQSLFRPILMVDKNLITANTGTSVETEMFDVYVDTFLSMFDVDDKSLNALIATA
Rat-CoV GCMRFLFYERDGRQVYDDVSA----SLFVDMNGLLHSHKVK---GVPETHVVVVENE--ADKAGFLGAAVFYAQSLYRPEMLMVEKLIITANTGLSVSRQTFMDLYVDSLNLVLDVDRKSLTSFVNAA
SARS-CoV NGALHLYFDKAGQKTYERHPL----SHFVNLDNLRANNTK---GSLP--INVIVFDGKSKCEDESASKSASVYYSQMLCOPIILLDOALVSDVGDSTEVSVKMFDAYVDTFSATFSVPMEKLTALVATA
229E NGFYRLYS---GE--TFWRYNFDITESKYSCKEVFKNCNVL-----DDFIVFNNT--GTNVTQVKNASVYFSQQLCRPIKLVDSLELLSTLSVDF--NGVLHKAIDVLRNSFGKDLNANMSLADC-
Bat-CoV-1A NGSYYLYS---GE--TFWRYNFDVTEAKYGCKEVLKNCNVL-----SDFIVYNNNT--GTNVSQIRNACVYFSQMLCKPIKLVDSALLSTLNVDVDF--NGALHSAFVQLVNDVDFSGKDLSSCASMTEC-
BtCoV512 NGFYLYS---GS--TFWKYNFDITEAKYACKDVLKNCNIL-----TDFVVFNNS--GSNVTQVKNACVYFSQQLCKPIKLVDSALLASLNVDVDF--SANLHKAFFVEVLNSFSGKDLSSCNMNEC-
BtMr-AlphaCoV NGFYRLYS---GD--TFWRYNYDITESKFSCKEVLKNCNTV-----DDFIVYNNNT--GTNVTQVRNACVYLSQLMCRPIKLVDAQLLSSLNVDVDF--NGALHKAFFVEVLNSFSGKDLSSCNMNEC-
BtNv-AlphaCoV NGFYLYS---GE--TFWRYNFDITSSKYSCKEVLKNCNIL-----SDFIVFDNN--GTNVSQVKNACVYLSQLLCKPIKLVDSALLSTLNVDVDF--NGALHSAFVQLVNDVDFSGKDLSSCNMNEC-
BtRf-AlphaCoV NGFYLYGPD--N--VFWRYNFDITESKYGCKDVLKNCNIL-----SDFIVYNNNT--GSNVAQVRNACVYFSQQLCKPIKLVDSALLSTLNVDVDF--NGALHSAFVQLVNDVDFSGKDLSSCNMNEC-
CDPHE15 NGFYLYS---GN--TFWKYNFDITDSRYSCKEALKTCNVA-----ADFIIICNNT--GSNMAQVKNACVYFSQQLCKPIKLVDSALLSTLNVDVDF--STSIHSAFVEILTDSFGKDLSSCNMNEC-
FCoV DGFYRFYV---GE--EFTAYDYDVKHKYSSQEVKTMFL-----DDFIVYNNPS--GSSLASVRNVCVYFSQQLIGRPIKIVNSELLEDLSVDF--KGALFNAKKNVKNSEFNVDSVSECKNLEEC-
Ferret-CoV EGFYRLYT---GD--EYTRYNYDITDKKYSCKEVLKSLQLI-----DDFVYDPT--GTPANLHNAACVYWSQQLGKPIKLVNRDLIQSLTVDF--NGVLFDAHRRVINSFNVDSVADCKTLRGC-
HKU10 NGFYLYGDD--GK--TFWRYNFDITEGKYSCKEVLKNSNVL-----ADFIVYNNV--GSNLAQVKNACVYFSQQLCKPIKLVDSALLSTLNVDVDF--NGALHAAFFVEVLNSFSGKDLSSCNMNEC-
HKU2 DGFYRIFS---GD--KFWKYNFDITDKKYSCKEVLKNCNIL-----DDFIVFDNN--GSNLSQVKNACVYLSQLLCKPIKIDSTLLSSLNVDVDF--NGALHKAFLDVLHNSFGKDFSSCKTMHDC-
HKU8 DGFYLYS---GE--TFWRYNFDITDNKYSCKEALKNCNVL-----SDFIVYNDV--GSNITQVRNACVYFSQQLCKPIKLVNASLLSTLNVDVDF--NGALHSAFVQLVNDVDFSGKDLSSCNMNEC-
LuchengRn-CoV DGFYLYS---GE--QFWKYEFDVSSKFFDSENCIKDLSLG-----ADFMVYNDN--GTARANALNASVYFSQQLCKPIKLVNRVLLSSLTIDH--GSAMHEAYCKVLHNSFNKDFTRCTDLQNC-
Mink-CoV DGFYRFYT---GD--EYTRYNFDITDKKYSCKEVLKSLQL-----DDFVIYDPN--GTPANLHNAACVYWSQQLGKPIKLVNRDLIQSLTVDF--NGVLFLEAHRVGVNSFNVDSVSNCKTLREC-
NL63 NGFYRLYS---GD--TFWRYDFDITESKYSCKEVLKNCNVL-----ENFIVYNNNS--GSNITQIKNACVYFSQQLCEPIKLVNSELLSTLSVDF--NGVLHKAIDVLRNSFSGKDLSSCNMNEC-
NL63-related NGFYRLYS---GD--TFWRYDFDITEPKYGCKEVLKNCNVL-----ENFIVYNNNT--GSNVTQVKNACVYFSQQLCEPIKLVNSELLSTLSVDF--NGVLHKAIDVLRNSFSGKDLSSCNMNEC-
Porcine-EDV NGFYLYS---GD--TFWKYNFDITDSKYTCKEALKNCNII-----DDFIVFNNT--GSNVNQVKNACVYFSQMLCKPIKLVDSALLASLSVDF--GASLHSAFVQLVNSFSGKDLSSCNMNDQDC-
TGE DGFYRFYV---GD--EFTSYDYDVKHKYSSQEVKSMMLL-----DDFIVYSPS--GSALANVRNACVYFSQQLIGKPIKIVNSDLLEDLSVDF--KGALFNAKKNVKNSEFNVDSVSECKNLEEC-



| | 3820 | 3830 | 3840 | 3850 | 3860 | 3870 | 3880 | 3890 | 3900 | 3910 | 3920 | 3930 | |
|----------------------|--|----------------------|------------------------|--------------------------------|------------------------------------|--|----------------------|------------------|-------------------|--------------------|------------------------|-----------------------|---------------------|
| <i>Bat-BCoV</i> | KNSLNDGVPLEKVLKEFVAAAKQNC--AE-TDVEADSI | VNALQLTFKDDVDITKDSY | NDFVLTYNKVD | S--MTPYDLGVCIEV | GARHVNANVAKANAAL | IWNIDHYLL | SESFRRQIRRSARKNGL | | | | | | |
| <i>Bovine-CoV</i> | HSSIKQGTQICKVLDTF | LSCARKSC-SID-SDVD | TKCLADSVMSAVSAGLEL | TDESCNNLVPTYLKGDN | --IVAADLGVLIQNSAKHVQGNVAKIAGVSCI | IWSVDAFNQLSSDFQHKLKKACCTGL | | | | | | | |
| <i>Covid-19</i> | EAEIAKNSVSLDNVLS | TFISAARQGF--VD-SDVET | KDVEECLKLSHQSDIEVTGDS | CNNYMLTYNKVEN--MTPRDLGACT | DCSARHINAQVAKSHNIALI | IWNVKDFMLSLSEQLRQKIRSAAKKNNL | | | | | | | |
| <i>GCCDC1</i> | LHQIASGTSVEAVLKV | FVGSTREEARDLE-SDVD | TNLVSCIRMSHQDGEWTT | DSWNNLVPTYLKQET--LSTLEVGQLIT | SNARYINANMAKSAAVQIV | WRYADFARLSESVRRQLKIAARKTGL | | | | | | | |
| <i>HKU1</i> | HASLREGVQLEKVLDT | TFVGCVRKCC-SID-SDVET | TRFITKSMISAVAAGLE | FTDENYNNLVPTYLKSDN--IVAADLGVLI | QNGAKHVQGNVAKAANIS | CIWFIDAFNQLTADLQHKLKKACVKTGL | | | | | | | |
| <i>HKU14</i> | HSSIKEGVQLDKVLNT | TFISCAKSC-SID-SDVD | TKCADSVMSAVAAGIEL | TDES YNNLVPTYIKSDN--IVAADLGVLI | QNSSKHVQGNVAKIAGVSCI | IWSVDAFNQLSSDFQHKLKKACCTGL | | | | | | | |
| <i>HKU24</i> | HKSLAEGVQLEKVLNT | FIGCARKTC-SID-SDVD | TRCLADTMSTVAAGLDM | TDESCNNLVPTYIKSDN--IVAADLGVLI | QNNCKHVQGNVAKMAGVSCI | IWHVDVYNQLSSDFQHKLKKACVKTGL | | | | | | | |
| <i>HKU4</i> | RDCVRRGDDFQNVLKT | FTDAARGHA-GVE-SDVET | TMVVDALQYAHKNDIQL | TTECYNNYVPGYIKPDS--INTL | DLGLIDLKAASVNQTS | MRNANGACVWNSGDYMKLSDFSFRQIRIACRKCNI | | | | | | | |
| <i>HKU5</i> | RDCVRRGDDFQTVIKT | FTDAARGPA-GVE-SDVET | SSIVDALQYAKHDLQL | TTEGFNNYVPSYIKPDS--VATADLGLI | DLNAASVNQTS | SIRNANGACIWNSSDYMKLSDSLKRQIRIACRKCNI | | | | | | | |
| <i>HKU9</i> | LQQISSGMTVESVLKV | FVGSTRAEAKDLE-SDVD | TNDLVSCIRLCHQEGWEW | TTDSWNNLVPTYIKQDT--LSTLEVGQF | MATANAKYVNA | IAKGAAVNLIRYADFIKLSESMRRQLKVAARKTGL | | | | | | | |
| <i>Hedgehog-CoV</i> | KDCVRRGEDLQSVLKT | TFQAARVHA-NVE-SDVET | ASIVDGIQYAHKNDIEL | VTDSEFN | YIPSYVVPDS--IATVDLGLI | DLKAASVNPASMRNANGACVWNIDAYLKLSDSLKRQIRVACRKCNI | | | | | | | |
| <i>MERS-CoV</i> | RDGVRRGDNFHSVLT | TFIDAARGPA-GVE-SDVET | NEIVDSVQYAHKNDIQ | ITNESYNNYVPSYVVPDS--VSTSDLGLI | DCNAASVNQIV | LRNSGACIWNAAAYMKLSDALKRQIRIACRKCNI | | | | | | | |
| <i>MHV</i> | HNSLKEGVQLEQVMD | TFIGCARRKC-AID-SDVET | TKSITKSVMSAVNAGV | DFDDESCNNLVPTYVKS | DT--IVAADLGVLIQNNAKHVQANVAKAANVACI | IWSVDAFNQLSADLQHLRKRACSKTGL | | | | | | | |
| <i>OC43</i> | HSSIKQGTQIYKVLDT | TFISCAKSC-SID-SDVD | TKCLADSVMSAVSAGLE | LTDSCNNLVPTYLKSDN--IVAADLGVLI | QNSAKHVQGNVAKIAGVSCI | IWSVDAFNQFSSDFQHKLKKACCTGL | | | | | | | |
| <i>Rat-CoV</i> | HNSLKEGVQLEQVMD | TFVGCARRKC-AID-SDVET | RSITKSVMSAVNAGV | DFDDESCNNLVPTYVKS | DT--IVAADLGVLIQNNAKHVQSNVAKAANVACI | IWSVDAFNQLSADLQHLRKRACSKTGL | | | | | | | |
| <i>SARS-CoV</i> | HSELAKGVALDGVLS | TFVSAARQGV--VD-TD | VDTKDVI ECLKLSHSDLEVTG | DS CNNFMLTYNKVEN--MTPRDLGACT | DCNARHINAQVAKSHNVSL | IWNVKDYMSLSEQLRQKIRSAAKKNNI | | | | | | | |
| <i>229E</i> | ----- | KS--- | ALGLS- ISDHEFTSAISNAHR | CDVLLSDLSFN | NFVSSYAKPEE--KLSAYDLAC | CMRAGAKVNVANVLT | KDQTP | IVWHAKDFNSL | SAEGRKYIVKTSKAKGL | | | | |
| <i>Bat-CoV-1A</i> | ----- | KQ--- | ALGFD-VSDEEFVDAV | NAHRFNVLLSDNSFN | LLTSYAKPEE--QLSTHDVAT | CMRFNAKVVNHNVL | IKENVP | IVWLARDFQOL | SEGRKYL | VKTTKAKGV | | | |
| <i>BtCoV512</i> | ----- | RE--- | SLGLSDVPEEESA | AAVSEAHRYDVLIS | DSVFN | NLIVSYAKPEE--KLAVHDI | ANCMRVGAKVNVHNVL | TKDNV | PVWVLA | KDFIAL | SEEARKYIVRTTKTKGI | | |
| <i>BtMr-AlphaCoV</i> | ----- | KE--- | RIGLD-VSDDEFLAAV | TNAHRYDVLSEVFN | FNITSYAKPEE--KLSAFDCAQ | CVRAGAKIVNHNV | IVKEKLS | IVWLAKDFQALS | AEGRKYIVKTSKVKGL | | | | |
| <i>BtNv-AlphaCoV</i> | ----- | KS--- | LLGFE-VSDEDFYNA | VSDAHRFNILLTDS | IFNFI | TTYAKPEE--KFATHDA | AVCMRSGSKI | VNHNVL | IKENA | VVYQRDF | HALSEDCRKYIVKTSKQKV | | |
| <i>BtRf-AlphaCoV</i> | ----- | KT--- | ALDIE-ADDEDFVNC | VSNAHRFNLLTDL | SFN | FVTSYAKPEE--KLSTHDI | AACMRGSKVNVHNVL | VKENVP | IVWLAKDF | NMLSEGRKYIVKTAIKGI | | | |
| <i>CDPHE15</i> | ----- | RA--- | TLGFDDISDEDF | TGAVANAHR | YGLLLTDS | IFNFI | ITSYAKPEE--KMSVHDLA | ICMRSGARVANHNVL | VKENVP | VVWSAEAF | NALSESRKYIVKTSKVKGL | | |
| <i>FCoV</i> | ----- | YK--- | LCNLD-VTFSTFEMA | INNAHRFGILIT | DRSF | NFWPSKIKP | GSSGVS | AMDIG | CMTFDAKI | VNAKVL | TORGKSVVWLSQDF | STLSSTAQKVLVKTVEEGV | |
| <i>Ferret-CoV</i> | ----- | YE--- | ACKTD-VPYVFE | DVNNNAHRYDVL | MTDIS | YNNI | WLTYAKPEE--NLSTFDI | ANCIKAGAKV | SHNVLI | KENVP | IVWYAKDF | ISLSNEARQLLIKTSKAKGV | |
| <i>HKU10</i> | ----- | KT--- | ALDID-ADDEEFV | NGVSNHRYNTLL | SDLSY | NFN | VTSYAKPEE--KLSTHDLA | ACMRGAKVNVHN | ILVKENVP | IVWYAKDF | NMLSEGRRYVKTAKLKV | | |
| <i>HKU2</i> | ----- | KE--- | LLELD-VSDDFI | KVSDAHRFDVLI | TDTS | FN | NETSYAKPAE--KLSFDLA | HCMRSGAKVNVHNVL | IKEMPI | IVWNCV | DFAKLSVDARKYIVKTAKVKGV | | |
| <i>HKU8</i> | ----- | KQ--- | ALGFE-VSDEFL | NGVSDAHRNVLL | SDTSC | NNLV | TSYAKPEE--KLSVHDLG | TCMRFGAKVNVHNVL | IKENVP | VVWLASE | FHLLSEGRKYIVKTTKAKGV | | |
| <i>LuchengRn-CoV</i> | ----- | KS--- | VAGIE-CRSTF | ETGKLAHKFDILL | CNDS | AN | FVTTYAKAGT--RIGTADL | AVFNRESVRE | VSHAVL | ARNKTTI | VWSVNV | FSKLSGDTQDIYVRTTKAKGL | |
| <i>Mink-CoV</i> | ----- | YE--- | ACKTD-VPYHT | FEDVVVHAHRYD | VLMTDLS | FN | FWLTYAKPED--NLSTFDI | ANCI | IRANAK | VNHSVLS | SKENVP | IVWSATDFV | KLSGEAKHLLIKTAKAKGV |
| <i>NL63</i> | ----- | KA--- | TLGLT-VSDDFV | SAVANAHRYDVL | LLSDLS | FN | FFISYAKPED--KLSVYDI | ACMRAGSKVNVHNVL | IKESI | PIVW | GKDFNTLS | QEGKYL | VKTTKAKGL |
| <i>NL63-related</i> | ----- | KT--- | ALGLT-VSDDFV | SAVANAHRYDILL | SDLS | FN | FFTSYAKPEE--KLSAYD | VACMRAGSKVNVHNVL | TKEST | PVVWS | AKDFNTLS | QEGKYL | VKTTKAKGL |
| <i>Porcine-EDV</i> | ----- | KS--- | TLGFDDVPLDT | FNAVAEAHRYDVL | LLTDM | S | FNFTSYAKPEE--KFPVHDI | ATCMRVGAKI | VNHNVL | VKDSI | PVVWL | VRFIAL | SEETRKYIIRTTKVKGI |
| <i>TGE</i> | ----- | YR--- | ACNLN-VSFSTF | EMAVNNAHRFGILIT | DRSF | NFWPSKIKP | GSSGVS | AMDIG | CMTSDAKI | VNAKVL | TORGKSVVWLS | SODFAAL | SSTAOKVLVKTVEEGV |



3940 3950 3960 3970 3980 3990 4000 4010 4020 4030 4040 4050 4060

Bat-BCoV QFKLTCSKNRQVTPFLT----TKIMFSG-GATYTTWLKRL-----KQAMVLLVCCILYCLLPSFKSQPLNMYSEIIDFKVIEDGSLRDIADDTFCFSNKHSSFVSWLSRNGF-KMTTTSRH

Bovine-CoV KLKLTYNKQMANVSVLT----TPFSLKGGAVF-SYFVY-----VCFLLSLVCFIQLWCLMPTYTVHKSDFLQPVYASYKVLNDGVIIRDVSVEDVCFANKFEQFDQWYESTFGLSYYSNSMA

Covid-19 PFKLTCATTRQVNVVVT----TKIALKG-GKIVNNWLKQLI-----KVTLVFLFVAIAFYLIITPVHVMKSHDFSEIIGYKAIDGGVTRDIADDTFCFANKHADFDTWFSQRGG-SY-TNDKA

GCCDC1 SLQLTTSNLKADVACVV----TPFKVVGGNKRVI PWRSILV-----HVLMLLVVLPQ--WFTPWYIMR---AVPYDVIDFKVIDNAILRDIPTDTCFANKFETFDNWFYHNRFQ-TY-ENNWR

HKU1 KLKLTYNKQEASVPILT----TPFSLKGGVVL-SNLLY-----ILFFVSLICFILLWALLPTYSVYKSDIHLPAYASFVIDNGVVRDISVNDLFCANKFFQFDQWYESTFGLSYVYHNSMD

HKU14 KLKLTYNKQSSNVSILT----TPFSLKGGAVF-SYFVY-----SCFVVSILICF IGLWCLMPTYSVHKSDFELPIYASYKVLNDGVIIRDVSVDVCFANKFEQFDQWYESTFGLTYYSNSMA

HKU24 KLKLTYNKQAANVSILT----MPFSLKGGALV-SNVLF-----KCFIASLIVFCTLWLFMPSYSVHKSAYELPAYASFVIDNGVVRDVKDVCFANKYAQFDQWYESTFGLSYYSNHHS

HKU4 PFRLTTSKLRAADNLS----VKFSATKIVGGAPSWLLRVRDLTVKGYCILTTFVFTVAVLSWFCLPSYSIATVNFNDRILTYKVIENGIIRDIAPNVCFANKYGFHFSKWFNENHG-GVYRNSMD

HKU5 PFRLTTSRLRSADNLS----VKFSATKLSGGAPKWLKLRDFTWKS YCVVTLVVFAMAVLSYLCLPAFNMSQVSHEDRILTYKVVENGIIRDITPSDTCFANKYQSFKWFNEHYG-GLFNNDIS

HKU9 NLLVTTSSLKADVPCMV----TPFKIIGGHRRIVSWRRVLI-----HVFMLLVVLPQ--WFTPWYIMR---PIEYNVVDVKVIDNAVIRDITSAQCFANKFSAFENWYSNRYG-SY-VNSRG

Hedgehog-CoV NFKLTTSKLRAQDNLS----VKFSVTKFVGGSLN--SKLGSFLFKMYAGFTICLVILAAILMYCILPTFNMAKVDNDRILGYKVLNDGVIIRDIGIDDKCFVNKYNTFDQWYQEFQ-NSYDNDYN

MERS-CoV AFRLTTSKL RANDNLS----VRF TANKIVGGAPTWFNALRDFTLKGYVLATIIIVFLCAVLMYLCPLTFSMAPVEFYEDRILDFKVLNDGVIIRDVNPDDKCFANKHRSFTQWYHEHVG-GVYDNSIT

MHV KIKLTYNKQEANVPILT----TPFSLKGGAVF-SRMLQ-----WLFVANLICFIVLWALMPTYAVHKSDMQLPLYASFVIDNGVLRDVSVDACFANKFNQFDQWYESTFGLAYRNSKA

OC43 KLKLTYNKQMANVSVLT----TPFSLKGGAVF-SYFVY-----VCFVLSLVCFIQLWCLMPTYTVHKSDFLQPVYASYKVLNDGVIIRDVSVEDVCFANKFEQFDQWYESTFGLSYYSNSMA

Rat-CoV KIKLTYNKQEANVPILT----TPFSLKGGAVF-SKFLQ-----WLFVANLICFIVLWALIPTYAVHKSDMQLPLYASFVIDNGVLRDVSVDACFANKFNQFDQWYESTFGLAYRNSKA

SARS-CoV PFRLTTCATTROVNVVIT----TKISLKG-GKIVSTCFKMLM-----KATLLCVLAALVCYIVMPVHTLSIHDGYTNEIIGYKAIODGVTRDIISTDDCFANKHAGFDQWYESTFGLSYYSNSMA

229E TFLLTINENQAVTQIPA----TSIVAKQAGDA----GHSLTWLWLL---CGLVCLIQFYLCF-FM--PYFMHDVVSSEFEGYDFKYIENGQLKNFEAPLKCVRNVFENFEDWHYAKFG-FTPLNKQS

Bat-CoV-1A TFLLTFNNTAMNVKLP----ISIVNKKGAGVS-----S--SFLWVL---CAAIITFFFCVGI-S-----EGLIATSLLEGFGFKYIKDGMHDFDKPLSCVHNVDNFNWSWHEARFG-SIPSNLSK

BtCoV512 NFMLTFNDRRMHLTIPT----ISVANKKAG-LPSLFTRLYSFFWHL---CVLIVLVFVATSL-L---D--FSAQVTSDTQYDFKYIENGVLKVFEPKPLDCVHNAFVNFNEWHNAKFG-SIPTNSRR

BtMr-AlphaCoV NFILTLNDNAQCSVPV---VSMMSKKGAGPK-----KSLWFLWGL---CAFILALYATSY-I---T--FGTMVGSFPGYDFKYIEHGQLQEFSHGLTCVHNVDNFMMEWHFQKFG-NTPSTGKA

BtNv-AlphaCoV NIMITFNDRMNVAIIPA---VNFVCKKGAIAK----P-FGWLCIV---FAFIFALYMSVGL-F---D--FTESVPYMGYDFKYIEGRLHDFTERLDCVHSVDFDWHESKFG-TVPTKSIK

BtRf-AlphaCoV NFMLTFNENRMQTTIPT----VSIAGKKGSGLK----QCYNFIWWS---CAFILFMFAIGL-L---D--FSTTVTASEYDFKYIIGGKLSFEKPLDCVHNVDNFNFWQAKFG-FVPRNSRS

CDPHE15 TFMLSFNNVRMHTTIPS---VAISGKKGSTVSFAFFKNLRKILWCS---CTIILCLFFVTSL-W---N--FAESYHSGSEFGYKYIENGALKDFSGPLDCVHNI FDDFMAWHHAKYG-VQFINRR

FCoV NFSLTFNAVGSDEDLPERFTESVSAKSGSFFDVL-KQLKQLFWCL---VLFITLYGLCSVY-----SVATQSYIDS AEGYDMVIKNGVVSQSFDDSDINC VHNTYKGFVWFKAKHG-FVPTFDKS

Ferret-CoV TIMLSFNQPMSTLPT----VAIGRKS GSGFFDVY-REFKQVIMLI---VAVLLAWGLCCYIY-----DGYTPARVSSAPGYDFMVIKNGVVSQSFDDSDINC VHNTYKGFVWFKAKHG-FVPTFDKS

HKU10 NFLLTFNDRMOTQIPV---VSVTTKCGSIR-----RCYNIWVI---CAFILCVLATGF-V---D--YTSMVVSASDYDFRYIEGGLKVFETPLKCVHNTFANFDNWNYSKFG-FTPSKDKR

HKU2 TFLLTVNNNVMTTLPC---VSVLQKQAGKL---SSMWNFWYA---CGAILALFVLLNC-V---G--FTEYASSLPYDFKYIEGGLKVFETPLKCVHNTFANFDNWNYSKFG-FTPSKDKR

HKU8 TFLLTFSNPMQLNIPS---TSIVNKRAGVG-----S--KFFWV---CLAIVAFLLLNA-S---E--FGYVATSFEDFGFKYIEHGVLKDFDGPLSCVHNVDNFNWHEARYG-VVFINRRI

LuchengRn-CoV LFLLTNDHVNTQNLPC---TMVNSKSAAGFPNMR-LWRFG LARTC---CYMILAAAFAYCAVWVSSINFKPAFDSVPEYDFRYIEDGAMKFFSKELPCVYNLYKDFPDWHKQRFQ-SVPTFSSS

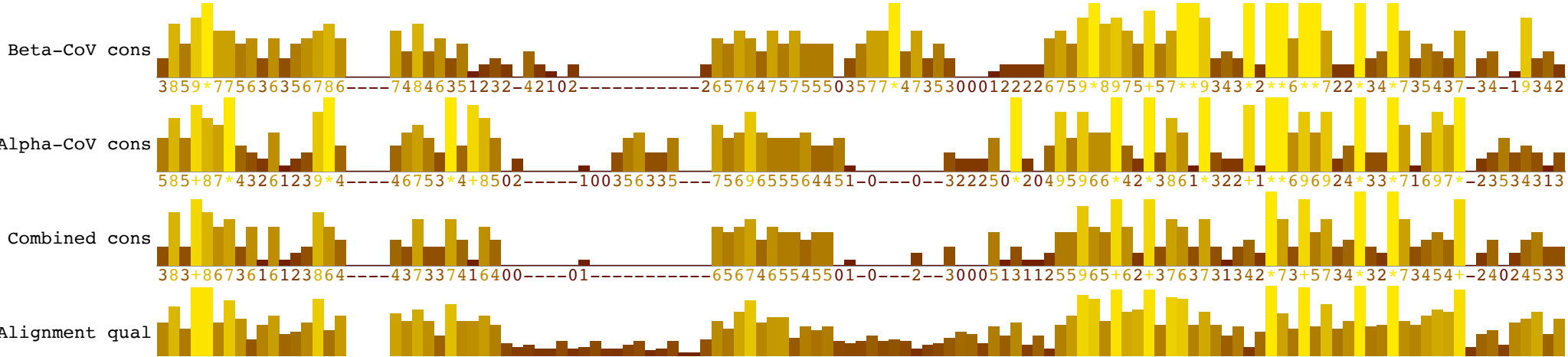
Mink-CoV TIMLTLNTNVMSHNLPA---VAIGRKS GSGFFDIY-NECKQVLRLL---LAIVLVWGLFSCY-----NGYTPTYVTSAVGYDFMLIKNGKIQSFDDSDINC VHNTYKGFVWFKAKHG-FVPTFDKS

NL63 TFLLTNDNQAITQVPA---TSIVAKQAGGFK-----RTYNFLWYV---CLFVVALF IGVS--FI--D--YTTTTSFHYGDFKYIENGQLKVF EAPLHCVRNVFDNFNQWHEAKFG-VVTTNSDK

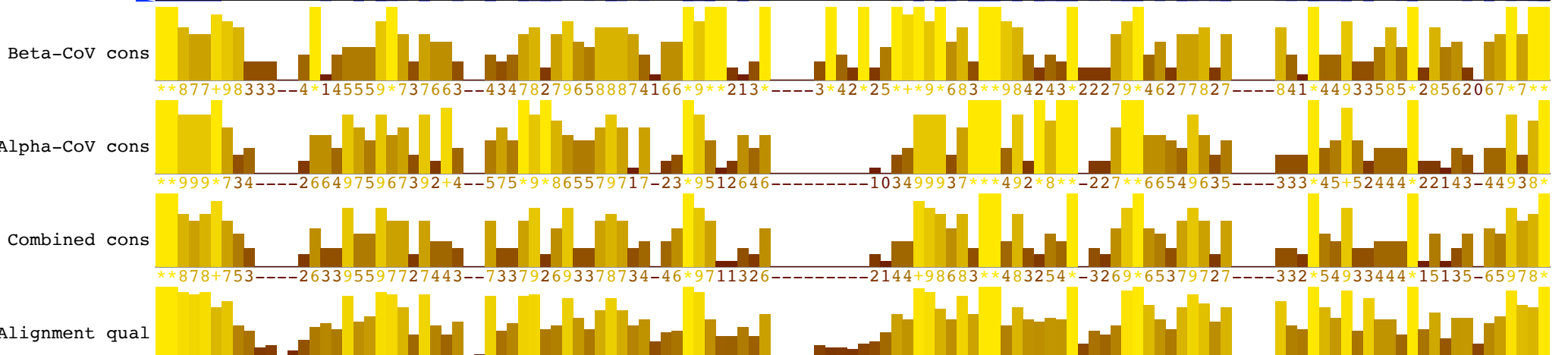
NL63-related SFLLTNDNQAITQVPA---TSIVSKQAGGFK-----RTFNFLWYT---CFIIVALFVIGIS--FI--D--YTTTTSFDPYDFKYIENGQLKVF EAPLHCVRNVFDNFNQWHEAKFG-VVPTNSDK

Porcine-EDV TFMLTFNDCRMHTTIPT----VCIANKKAG-LPS-FSKVKFFWFL---CLFIVAAAFALS-L---D--FSTQVSSDSYDFKYIESQLKVFETPLKCVHNTFANFDNWNYSKFG-FTPSKDKR

TGE NFSLTFNAVGSDDDLPERFTESVSPKSGSFFDVI-TOLKOIVILV---FVFIICGLCSVY-----SVATOSYIESAEGYDMVIKNGIVOPFDDTISCVHNTYKGFVWFKAKYG-FIPTFGKS



| | 4070 | 4080 | 4090 | 4100 | 4110 | 4120 | 4130 | 4140 | 4150 | 4160 | 4170 | 4180 | 4190 |
|----------------------|---|--|-----------------------------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | CPITVAVVAKK--VGDVIPSPLPGVVTRVLVVRGQIMHFLARVFSAAANICYTPGTLT | ----EYEDFLTSACVLPAAECTIFKDSNGIAVPPYCYDVNALQG---- | SLPYSSLKHDVLYQLVDN--SFIKFP | | | | | | | | | | |
| <i>Bovine-CoV</i> | CPIVVAVVDQD--LGSTVFNVPVKVLRV--GYHVLHFITHALSADGVQCYTPHSQI | ----SYSNFYASGCVLSSACTMFAMADGSPQPYCYTEGLMQN---- | ASLYSSLVPHVRYNLANAKGFIKFP | | | | | | | | | | |
| <i>Covid-19</i> | CPLIAAVITRE--VGFVVPGLPGTILRT--TNGDFLHFLPRVFSAVGNICYTPSKLI | ----EYTDFAFSACVLAACCTIFKDSAGKPPYCYDTNVLEG---- | SVAYESLRPDTRYVLMGDG--SIIQFP | | | | | | | | | | |
| <i>GCCDC1</i> | CPMVVGVVKEL--VGVLPKDLVRFVLRV--GTTLLPLVNFNGMSGADSVCYTPYSAT | ----SYSDFETSACVLAACCTIFGTGVGQPAPYCADPTLIPN---- | ATHYGLMKPHVLYPPFYETAGYIRFP | | | | | | | | | | |
| <i>HKU1</i> | CPIVVAVMDED--IGSTMFNVPTKVLRH--GFHVLHFLTYAFASDSVQCYTPHIQI | ----SYNDFYASGCVLSSSLCTMFKRGDGTTPHYCYSDGVMKN---- | ASLYTSLVPHTRYSLANSNGFIKFP | | | | | | | | | | |
| <i>HKU14</i> | CPIVVAVIDQD--IGSTVFNVPVKVLRV--GFHVLHFITHALSTDSVQCYTPHYQI | ----PYSNFDYSGCVLSSACTMFAMSDGKPPFCYTDGLMNN---- | ASLYSSLAPHVRYNLANVKGYIRFP | | | | | | | | | | |
| <i>HKU24</i> | CPVVVAVIDKD--IGSTVFNVPVKVLRV--GYHVLHFITYAFSADGVQCYTPHEQI | ----SYSDFYSSGCVLSSACTMFASDNGASQAYCYTEGLVQN---- | ASLYSSLRPHVRYSLANTHGYIRFP | | | | | | | | | | |
| <i>HKU4</i> | CPITIAVIAGV--AGARVANVPANLAWV--GKQIVLFFVSRVFANT--NVCFTPINEI | ----PYDTFSDSGCVLSSECTLFRDAEGNLPFCYDPTVLPG---- | ASSYADMKPHVRYDMYSDMYIKFP | | | | | | | | | | |
| <i>HKU5</i> | CPVTVAVIAGV--AGARVPNLPANVAWV--GRQIVLFFVSRVFASSNNVCTPTAEI | ----PYERFSDSGCVLASECTLFRDAEGKINPPCYDPTVLPG---- | ASAYDMKPHVRYDMYSDMYIKFP | | | | | | | | | | |
| <i>HKU9</i> | CPMVVGVVSDI--VGSVLPGLPARFLRV--GTTLLPLVNYGLGAVGSVCYTPHYAT | ----NYDVFDTSACVLAACCTLFRSASGERMPYCYDAALIQN---- | ASRYDMLKPHVMYPPFYEHSGYIRFP | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | CPVVVAVIAGI--SGERVPGVPTSLIWA--GNQILFFVSRVFATNNNICYTPHMEI | ----AYERFSDSGCVLSAECTLFRDAVGSMPYCYDANVLPG---- | AVPYDTMLPHVRYDLYDSNMFIKFP | | | | | | | | | | |
| <i>MERS-CoV</i> | CPLTVAVIAGV--AGARIPDVPTTLAWV--NNQIIFVSRVFANTGVSVCYTPIDEI | ----PYKSFSDSGCILPSECTMFRDAEGRMTPYCHDPTVLPG---- | AFAYSQMRPHVRYDLYDGNMFIKFP | | | | | | | | | | |
| <i>MHV</i> | CPVVVAVIDQD--IGHTLFNVPTTVLRY--GFHVLHFITHAFATDSVQCYTPHMQI | ----PYDNFYASGCVLSSSLCTMLAHADGTPHPYCYTGGVMHN---- | ASLYSSLAPHVRYNLANASNGYIRFP | | | | | | | | | | |
| <i>OC43</i> | CPIVVAVIDQD--FGSTVFNVPVKVLRV--GYHVLHFITHALSADGVQCYTPHSQI | ----SYSNFYASGCVLSSACTMFTMADGSPQPYCYTEGLMQN---- | ASLYSSLVPHVRYNLANAKGFIKFP | | | | | | | | | | |
| <i>Rat-CoV</i> | CPVVVAVIDQD--IGHTLFNVPTKVLRY--GFHVLHFITHAFATDSVQCYTPHMQI | ----PYDNFYASGCVLSSSLCTMLAHADGTPHPYCYTEGMVHN---- | ASLYSSLVPHVRYNLANASNGYIRFP | | | | | | | | | | |
| <i>SARS-CoV</i> | CPVVVAITITRE--IGFIVPGLPGTVLRA--INGDFLHFLPRVFSAVGNICYTPSKLI | ----EYSDFAFSACVLAACCTIFKDSAGKPPYCYDTNLLG---- | SISYSELREDTRYVLMGDG--SIIQFP | | | | | | | | | | |
| <i>229E</i> | CPIVVGVSE---IVNTVAGIPSNVYLV--GKTLIFTLQAAFGNA--GVCYDIFGVT | -----TPEKCIFTSACTRLEGLGG--NNVVCYNTELMG---- | SLPYSSIQANAYKYDNG--NFIKLP | | | | | | | | | | |
| <i>Bat-CoV-1A</i> | CPIVVGTLD---DVRNVPGVPSGILLV--GKTLVFAIKAVFTDA--GNCYGLNGLT | -----NAGACLFNSACTKLEGLGG--THVICYKDLGFEF---- | SKRYSDLVPHSNYKMEDG--NFVKLP | | | | | | | | | | |
| <i>BtCoV512</i> | CPIVVGTSD---EVRYPGPVAGVFLY--GKSLIFAMSTIFGTS--GLCFDDRGLT | -----DPDSCIFNSACTTSLGIGG--RNVICYREGVVDN---- | AKLYSSLPHSYRRLMDG--NHIVLP | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | CPVIVGVGD---NGRTLPGVPADVHLV--GQTLVFTVKSVMFGNT--NLCYDTSQV | -----SAASCIFISACTVLEGLGG--ISTYCYKDGIVEG---- | AKLYSDLQPNAHYKFDND--NFVKLP | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | CPVIVGVSD---SVRTLPGVPAGMLV--GKTLVFAVKTVMGET--GNCYDTQGV | -----STSSCLFNSACTVLEGLGG--TITYCYKDGIVEG---- | ARTYSELVNTYKMEDG--RHVIFP | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | CPVIVGVND---EARVIPGVASGVSIV--DKTLVFAVKSVMFANS--ATCYDITGPA | -----PAERCVFNSACTTTLNGLGG--LATYCYKNGLVEG---- | AKLYTDLQPNASHYSMADG--GVVKLP | | | | | | | | | | |
| <i>CDPHE15</i> | CPVIVGVDE---NVRTIPGVASGVMV--GKTLVFAVKSVMYSSA--GLCYDEFGAA | -----APEQCLFNSACTTTLKGLGG--TSTYCYRSLVSD---- | SGLYRDLHLHSHYFLPDG--NYVKFP | | | | | | | | | | |
| <i>FCoV</i> | CPVILGTVFDL--GNMRPIPDVPAYVALV--GRSLVFAINAAGVGT--NVCYDHTGAA | -----VSKNSYFDTCVFNSACTTTLTGIGG--TVVYCAKQGLVEG---- | AKLYSELFPDYEYEHASG--NMVKIP | | | | | | | | | | |
| <i>Ferret-CoV</i> | CPVIVGTVFDI--IDSMKPPVDPVAVYTLV--GRSLVFAINAVFGNT--DLCYDHQGVA | -----KSRDSVFNCFVNAACQTLVGMGG--TAVYCFKDGVMVG---- | AHKTAYELIPDTHYMLRDG--NTLKL | | | | | | | | | | |
| <i>HKU10</i> | CPVIVGVSN---EARTIPGVPSGVFLF--GKTLVFAVQIVFGGS--HTCYDMTGPA | -----PLDRCIFNSACTTTLNGLGG--ERVYCYKNGLVEG---- | SLLYTDLQPNSSYSLPVG--GYVRLP | | | | | | | | | | |
| <i>HKU2</i> | CPVIVGASD---SGRVVPGVASDVYLL--GKTLIFTLKTVFGSA--GHCYDVNGIA | -----DGDKCIFNSACTNLEGLGG--TRTYCYKGLIEG---- | AMTYGDLQHSYRSLSGD--NYVRLP | | | | | | | | | | |
| <i>HKU8</i> | CPVIVGTID---NIRFPVNPVSGIVLI--GKTLVFAVKAFTET--GNCFNLNGLT | -----TLGSCIFNSACTNMDGLGG--PATYCYKEGLFEN---- | SKLYSDLVPHSHYKLEDG--NFIKLP | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | CPVIVGAND---LNTNVVNPVANSVALS--GRILVFTYQTLFGHS--KLCFNDAYNNSMAKISAGDCERAAIFPSACTTLQGVGG | -----RQVYCFDGLYAG---- | AKLYSDIMPHLRYSDVN--NYVMLP | | | | | | | | | | |
| <i>Mink-CoV</i> | CPVIVGTVFDL--VDNMRPVPVDPVAVYTLV--GRSLVFAINAVFGNT--DLCYDHQGVA | -----KSRNSIFNCFVYNAACQTLVGMGG--TAVYCFKEGVMNGNILQHKTYADIAPETFYELKDG--NMVKIP | | | | | | | | | | | |
| <i>NL63</i> | CPVIVGVSE---RINNVVPGVPTNVYLV--GKTLVFTLQAAFGNT--GVCYDFDQV | -----TSDKCIFNSACTRLEGLGG--DNVVCYNTDLIEG---- | SKPYSTLQPNAYKYDAK--NYVRF | | | | | | | | | | |
| <i>NL63-related</i> | CPVIVGVSE---RTNVVPGVPANVYLI--GRTLVFTLQAAFGNT--GVCYDFDQV | -----TSDKCIFNSACTKLEGLGG--NNVVCYNTGLMEG---- | SKPYSDLQPNAYKYDGR--NYVRF | | | | | | | | | | |
| <i>Porcine-EDV</i> | CPVIVGVSD---EARTVPGIPAGVYLA--GKTLVFAINTIFGTS--GLCFDASGVA | -----DKGACIFNSACTTSLGLGG--TAVYCYKNGLVEG---- | AKLYSELAPHSYKMDVG--NAVSLP | | | | | | | | | | |
| <i>TGE</i> | CPVIVGTVFDL--ENMRPIPDVPAYVSIIV--GRSLVFAINAAGVGT--NMCYDHTGNA | -----VSKDSYFDTCVFNTACTTTLGGLG--TIVYCAKQGLVEG---- | AKLYSDLMPDYEYEHASG--NMVKLP | | | | | | | | | | |



4200 4210 4220 4230 4240 4250 4260 4270 4280 4290 4300 4310

Bat-BCoV KVLVEG-AFRIVRTMTQYCRHGVCEDSMAGLCLSLRGSWVLNNPYYSQSQSVYCGNDVVDLLMNLAPMFRPAGGMDITSSIVAGGILSLVITVVVAYYILKLRRAFGDYQOVVVVNTLAF LCSFLV

Bovine-CoV EVLREG-LVRIVRTRMSYCRVGLCEEADEGICFNFNNGSWVLNNDYRSLPGTFCGRDVFDLIYQLFKGLAQPVDFLALTASSIAGAILAVIVLVFYYLIIKLKRAF GDYTSIVFVNVIVVCVNFMM

Covid-19 NTYLEG-SVRVVTTFDSEYCRHGTCESEAGVCSVSTSGRWVLNNDYRSLPGVFCGVDANLLTNMFTPLIQPIGALDISASIVAGGIVAVVTCLAYYFMRFRFAFGEYSHVAFNLTLLFMSFTV

GCCDC1 EVI-DA-GVHIVKLMAMEYCKVGRCDVSEAGVCVTLTPMWWVNNPYFRQLPGVYCGASFMDMLQVFTPMFTPVGAVDITGSIIMGACLAVISMVLYLLKFRRAF GDYSSVVLVNIIAFVNVLV

HKU1 DVISEG-IVRIVRTRSMYCRVGLCEYAEEGICFNFNSSWVLNNDYRSMPTGFCGRDLFDLFYQFSSLRIPIDFFSLTASSIFGAILAVIVLVFYYLIIKLKRAF GDYTSVVVINNVVWCINFLM

HKU14 EVLREG-LVRIVRTRSMYCRVGLCEVSDGEGICFNFNNGSWVLNNDYRSLPGTFCGRDVFDLVYQFLSGLSQPVDFALTASSIAGAILAVIVLVFYYLIIKLKRAF GDYTSVVVVNVIVVFNFLM

HKU24 EVLREG-LVRVIRTKAMTYCRVGLCESAEEGICFTFNNGSWALNNEYRKMPTGFCGRDVFDFINQFVVGLAQPIDFFSLTSSVVGAVLAIIVLFIYLYLIIKLKRAF GDYTAVVVVNVIVWFVNFVM

HKU4 EVIVES-TLRITKTLATQYCRFGSCESAAGVCI STNGSWALYNQNYSTRPGIYCGDDYFDIVRRLAISLFPQVTFYQLSTSLAMGLVLCVFLTAIFYINKVKRALADYTCAVVAVAALLNSLC

HKU5 EVVFE-S-TLRITKTLATQYCRFGSCEDANEGVCI STNGSWAIYNNDHYANKPGVYCGDNYFDIVRRLGLSLFPQVTFYQLSTSLALGVMCI FLTIIFYVNVKRALADYTCAVVAVAALLNSLC

HKU9 EVI-SA-GVHIVRMTAMEYCKVGRCDVSEAGL CMSLQPRWVNNAYFRQOSGVYCGTSAFDLFMNMLLPIFTVPVAVDITTSILMGALLAVVVSMSLYLLRFRAF GDYSGVIFTNIIAFVNVIV

Hedgehog-CoV EVIVEG-TLRVVKTLKTQYCRVGLCEWSEAGICVSTNGSWMLNNEHYASKPGVYCGSDYLDMVRRSFMSVFPITYFQLTTSLFMGLCLCLGIVVIFYVNVKFRADYTCVLIIVMATGLNGLC

MERS-CoV EVVFE-S-TLRITRRLSTQYCRFGSCFYAQEGVICITNGSWAIFNDHHLNRPVYCGSDFIDIVRRLAVSLFPQVTFYQLSTSLVLGIGLCAFLTLLFYINKVKRAFADYTCAVIIVVAALLNSLC

MHV EVVSEG-IVRVVTRSMYCRVGLCEEADEGICFNFNRSWVLNNDYRAMPPTGFCGRNADFIIHQVLGGLVRPIDFFALTASSVAGAILAVIVLAFYYLIIKLKRAF GDYTSVVVINNVIVWCINFLM

OC43 EVLREG-LVRIVRTRMSYCRVGLCEEADEGICFNFNNGSWVLNNDYRSLPGTFCGRDVFDLIYQLFKGLAQPVDFLALTASSIAGAILAVIVLVFYYLIIKLKRAF GDYTSVVFVNVIVVCVNFMM

Rat-CoV EVVSEG-IVRVVTRSMYCRVGLCEEADEGICFNFNSSWVLNNDYRAMPPTGFCGRNADFIIHQVLGGLVRPIDFFALTASSVAGAILAVIVLAFYYLIIKLKRAF GDYTSVVVINNVIVVCVNFMM

SARS-CoV NTYLEG-SVRVVTTFDAEYCRHGTCESEVGI CLSTSGRWVLNNEHYRALSQVFCGVDAMNLIANI FTPLVOPVVALDVASVAGGIIAILVTCAAYYFMKFRVFGYENHVVAANALLFLMSFTI

229E EVIAQGFGRFRTVRTIATKYCRVGECDVSNAGVCFGLDKWVNDGR---VNGYVCGTGLWNLVFNILSMFSSSFSVAAMSGQILLNCALGAFATFCFLVTKFRMFGDLSVGVCTVVAVLLNNS

Bat-CoV-1A ETLVNGFGINIIRTMETTYCRVGECLSKAGVCFGANRFFVYND---FGSDYICGNGLFSFVKLNFNTTMSVSVMALSGQVIFNCAVAALAI FICFLVVKFRMFGDLSYGVCSVIAAVTINNLS

BtCoV512 EIIIRGFGIRTIKTQAMTYCRTGECIDSQAGVCVGLDRFFVYSKT---PGSDYVCGTGFFSLLFNVI GMSNSIPVTVMMSGQILLNCVVAFTAVMACFAFTKFKRFGDMSFGVLSVGLCTVNNLS

BtMr-AlphaCoV EVLARGFGMRTVRTLDTTYCRVGECTESKAGICIGADRWLVSNAE---SGSDFVCGASLLQLLYNFRVFNDFSTAAALSGQMMFNVI VAGLAIMACFIITKFKRVFGDMSFGVFTVITALVCNLS

BtNv-AlphaCoV EVLARGFGFRVRTLATTYCRAGQCDKAGVCFGLDRFLVYSAD---SGSDFVCGNLLSLLYNVLAIFSSSFSVAALSGQIIFNLVVAIAVFCVFTVVKFRMFGDMSRGVCTVGAIVLNNLS

BtRf-AlphaCoV DVLASGFGFRTVKTQETTYCRVGCQVNSKAGVCFGANRFLVYND---SGTDFVCGTGLMSLMYNLLSVFSSSFSVMAMSGQIVLNCVAALFAIFACMLVTKFRMFGDLSLGVCSVICVAIVNNLS

CDPHE15 EVISRGFGFRTVRTAATTYCRVGCQVDSKQGVCFGLDRFLVYSAE---SGSDFVCGTGLMSLLYNVFGIFTRIPVVVLSGQIMFNCVVAFLAVSCFLFTKFKRFGDMSFGVFTVCCCVLNNLS

FCoV AI-IRSFGLRFVKTQATTYCRVGECTESQAGFCFGDNWFVYDKE---FGDGYICGSSTLGFCKNVFALFNSNMSVATSGAMLANIVIACLAIAVCYGLKFKKIFGDCTLLVMIIVTLVNNNS

Ferret-CoV TI-IRGFLRIVQTLATTYCRVGECTQSKQGFVGLDNWFVYDKA---FGEGYICGDSVFGFVTNVFKLFNQNLSVATSGYMLTNMLIALFAIIVCYAFLKFKRFGDCTMFVSMIIVTLFINNLS

HKU10 EVITSGLGFRTVRTQTTTCRMGECVDSKAGICFGANRFLVYSAE---SGTDFVCGTGLSLLLNVMNFSSSFSVLMAMSGQIVFNCVLTCVIIMACLLVTKLKRFGDLSLGVCTVVCVAVNNLS

HKU2 YVVVQGLGFRVVRTQATTYCRVGECDVSKAGMCFGADRWFVYSND---IGSDFICGSLVDLLRNILSVFNFMSTMI MSQVIFNVCVLAACVVVFGCYFVMKFRVFGDMSLAVFTVCAAVVNNLS

HKU8 ETLARGLGFVTIKTMETTYCRVGECLDSKAGVCFGLDRFFVYNT---FGDGYICGSGFLSFRNVLSIFTSSFSVMALSGQVMFNCAIAAVVVCFLVVKFRMFGDLSMGVCTVAVVNNNS

LuchengRn-CoV EVIMRGFGFKITRLEETTYCRVGECAKSNAGICVSADEWVYVDK---LGDYVCSKDFKGLVWAFVSVFNANIGTVLLTGQLTFNAFIACAIVGICYTFVKFRIFGDMSTLVMVLAATFINSMS

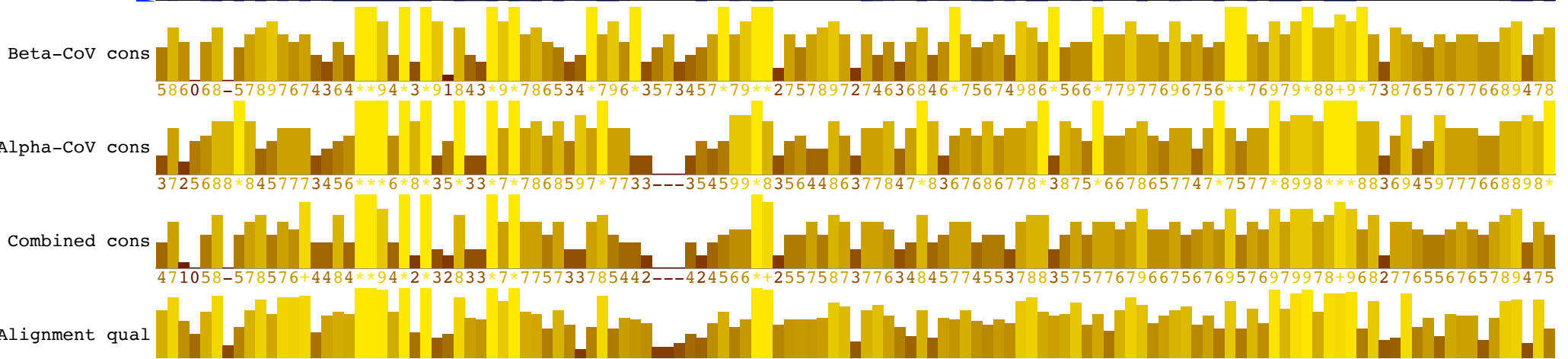
Mink-CoV TI-IRGLGLRVVQTLSTTYCRVGECTQSKGFCVGLDNWFVYDRS---FGDGYICGDSVFGFATNVFRLFNQNLSVATSGYMITNLI IALCAIAVCYFFLKFKRIFGDCSMLVTIIVITLLCINNIS

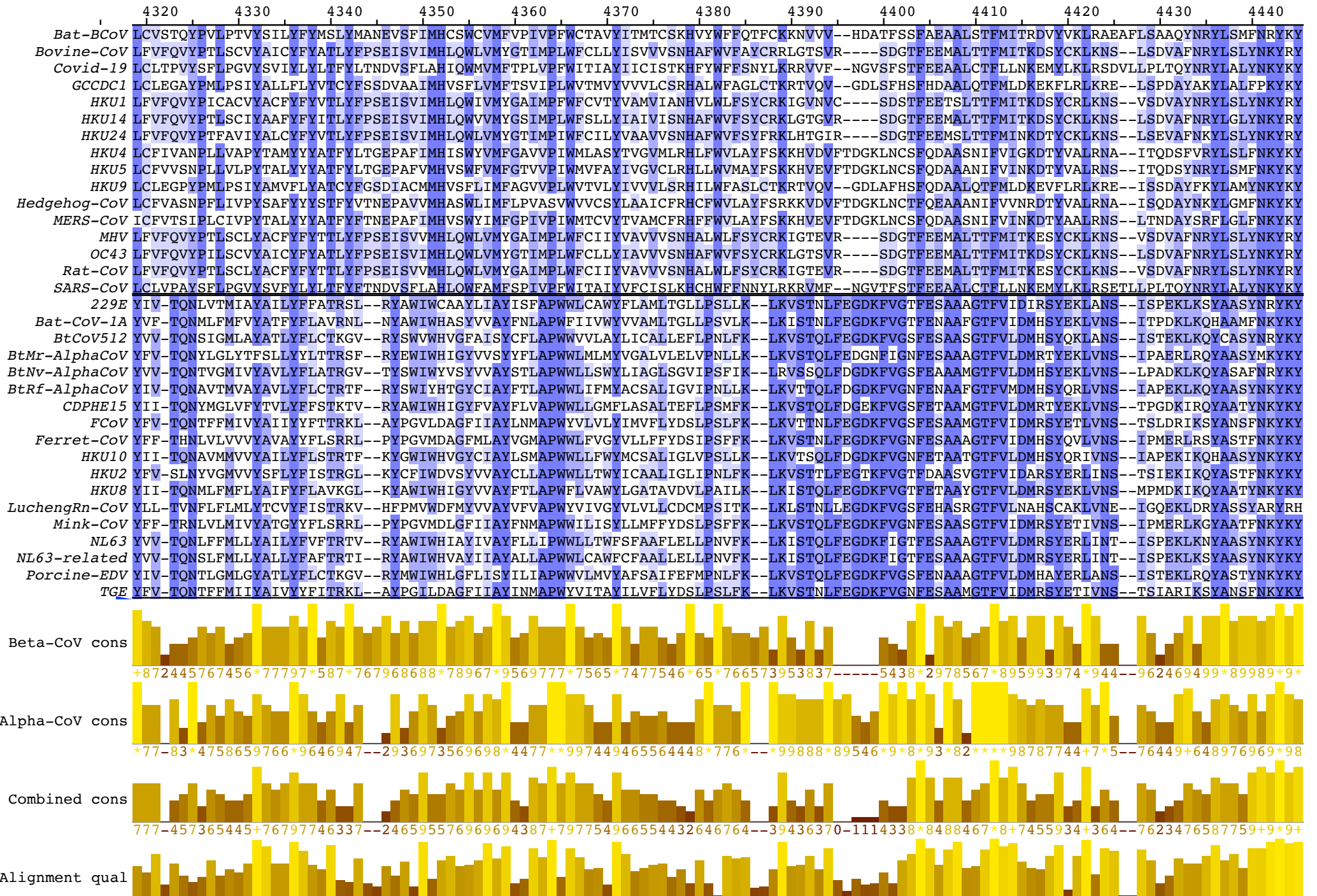
NL63 EILARGFGLRTIRTLATRYCRVGECDRSHKGVCFGLDKWVNDGR---VDDGYICGDLIDLLVNVLSIFSSSFSVAMSGHMLFNLF AAFITFLCFLVTKFRVFGDLSYGVFTVVCATLINNIS

NL63-related EILARGFGLRTIRTLATRYCRVGECDRSHKGVCFGLDKWVNDGR---FDDGYICGDLTDLVMNVISIFSSSFSVAAMSGHMLFNLF AALVIFLCFLVTKFRVFGDLSYGVFTVVCATLINNIS

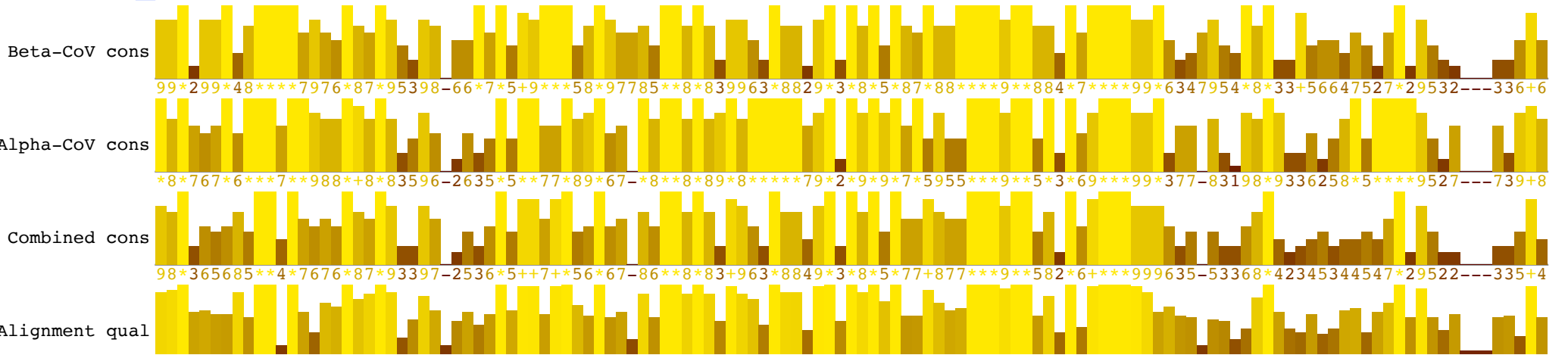
Porcine-EDV EIIISRGFGIRTIKTAMTYCRVGCQVSAEGVCFGADRFFVYNAE---SGSDFVCGTGLFTLLMNVISVFSKTPVPTVLSGQILFNCAIAFVAVAVCFLFTKFKRFGDMSVGVFTVACTLLNNS

TGE AI-IRGLGLRFVKTQATTYCRVGECDVSKAGVCFGANRFFVYDNE---FGNGYICGNSVLGFFKNVFKLFNSNMSVATSGAMLVNII IALCAIAMCYGLKFKKIFGDCTFLVMIIVTLVNNNS

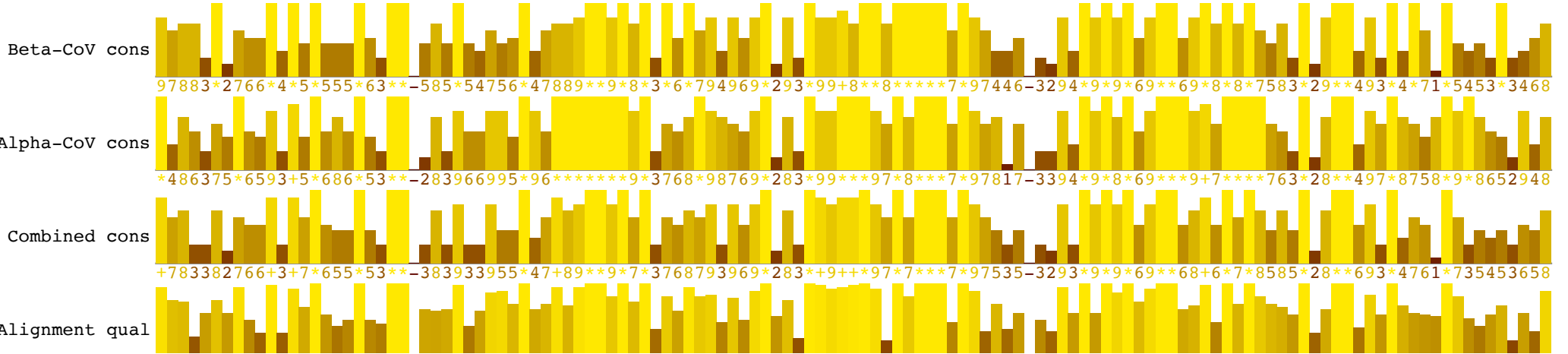




| | 4450 | 4460 | 4470 | 4480 | 4490 | 4500 | 4510 | 4520 | 4530 | 4540 | 4550 | 4560 | 4570 |
|----------------------|--|--|--------------------------------------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | FSGSMDTESYREAACCHLAKAMKDFS-EQGS | DILYQPPSCSLASAVLQSGIRKMSCPTGKVERCMVRVTCGTMTLNLGLWLDNTVYCPRHVMCTPEELLAPDYDSILLRKATHSFTVQYG--- | TAYLK | | | | | | | | | | |
| <i>Bovine-CoV</i> | YSGKMDTAAAYREAACSQLAKAMDTFTNNGSDVLYQPPTASVSTSF | LQSGIVKMNPTSKVEPCIVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | SASDMTNPDYTNLLCRVTSSDFTVLFD---RLSLT | | | | | | | | | | |
| <i>Covid-19</i> | FSGAMDTTSYREAACCHLAKALNDFS-NSGSDVLYQPPQTSITSAVLQSGFRKMAF | PSGKVEGCMVQVTCGTTTLNLGLWLDNVYCPRHVIC | TSEDMLNPNYEDLLIRKSNHNHFLVQAG---NVQLR | | | | | | | | | | |
| <i>GCCDC1</i> | YNGPMDTAAAYREAACAHLVMALEKFS-TGGGDSIYQPPRCSVAAATLQAGLAKMAHPSGLVEPCIVKVS | YGTMTLNLGLWLDNVYCPRHVIC | TRDDLVPDYQRLSMRAANYDFHVSQN---GLNLR | | | | | | | | | | |
| <i>HKU1</i> | YSGKMDTAAAYREAACSQLAKAMETFNHNNGNDVLYQPPTASVSTSF | LQSGIVKMNPTSKIEPCIVSVTYGSMNTLNLGLWLDKVKYCPRHVIC | SSSNMNEPDYSALLCRVTLGDFTIMSG---RMSLT | | | | | | | | | | |
| <i>HKU14</i> | YSGKMDTAAAYREAACSQLAKAMDTFTNNGSDVLYQPPTASVSTSF | LQSGIVKMNPTSKVEPCVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | SASDMTNPDPNLLCRVTSSDFTIMSD---RMSLT | | | | | | | | | | |
| <i>HKU24</i> | YSGKMDTAAAYREAACSQLAKALDTFNHNNGNDVLYQPPTASVSTSF | LQSGIAKIVCPTSKVEPCIVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | CAANDMVPDYEALLCRVTSTDFVVMFD---RMSLT | | | | | | | | | | |
| <i>HKU4</i> | YSGAMDTASYREAAHLCKALQVYS-ETGSDILYQPPNCSVTSSVLQSGLVKMSAPSGAVENCIVQVTCG | SMTLNLGLWLDNTVWVCPRHIMCPADQLTDPNYDALLISKTNHSFIVQKHIGAQANLR | | | | | | | | | | | |
| <i>HKU5</i> | YSGAMDTASYREAAHLCKALQVYS-ETGSDVLYQPPNCSVTSSVLQSGLVKMAAPSGVVENCMVQVTCG | SMTLNLGLWLDNTVWVCPRHVMCPADQLSDPNYDALLVSKTNLSFIVQKNVGPANLR | | | | | | | | | | | |
| <i>HKU9</i> | YSGPMDTAAAYREAACAHLVMALEKYS-NGGGDTIYQPPRCSVAAALQAGLTRMAHPSGLVEPCIVKVS | YGTMTLNLGLWLDNVYCPRHVIC | SRDELANPDYQRLSMRAANYDFHVSQN---GHNIR | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | FSGVMDTAAAYREASAAHLAKALQVFS-ENGSDLLYQPPNCSLASSVLQSGLVKMAHPSGAVEQCIVQVTCG | SMTLNLGLWLDNVYCPRHVMCPQDQLVDPNYDALLNSMTNHSFTIQRHGRSTANLR | | | | | | | | | | | |
| <i>MERS-CoV</i> | FSGAMETAAYREAAACHLAKALQVYS-ETGSDLLYQPPNCSITSGVLQSGLVKMSHPSGDVEACMVQVTCG | SMTLNLGLWLDNTVWVCPRHVMCPADQLSDPNYDALLISMTNHSFSVQKHIGAPANLR | | | | | | | | | | | |
| <i>MHV</i> | FSGKMDTAAAYREAACSQLAKAMETFNHNNGNDVLYQPPTASVSTSF | LQSGIVKMNPTSKVEPCIVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | SSADMTDPDYPNLLCRVTSSDFCVMSG---RMSLT | | | | | | | | | | |
| <i>OC43</i> | YSGKMDTAAAYREAACSQLAKAMDTFTNNGSDVLYQPPTASVSTSF | LQSGIVKMNPTSKVEPCVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | SASDMTNPDYTNLLCRVTSSDFTVLFD---RLSLT | | | | | | | | | | |
| <i>Rat-CoV</i> | FSGKMDTAAAYREAACSQLAKAMETFNHNNGNDVLYQPPTASVSTSF | LQSGIVKMNPTSKVEPCVSVTYGNMNTLNLGLWLDKVKYCPRHVIC | SSDDMTDPDYPNLLCRVTSSDFCVMSG---RMSLT | | | | | | | | | | |
| <i>SARS-CoV</i> | FSGALDITTSYREAACCHLAKALNDFS-NSGADVLYQPPQTSITSAVLQSGFRKMAF | PSGKVEGCMVQVTCGTTTLNLGLWLDNTVYCPRHVIC | TAEDMLNPNYEDLLIRKSNHSFLVQAG---NVOLR | | | | | | | | | | |
| <i>229E</i> | YSGNANEADYRCACYAHLAKAMLDFS-RDHNDILYTPPTVSYG-STLQAGLRKMAQPSG | FVEKCVRVVYGNMNTLNLGLWLDIVYCPRHVIASNT-TSAIDYDHEYSIMRLHNFSIISG--- | TAFLG | | | | | | | | | | |
| <i>Bat-CoV-1a</i> | YSGSASEADYRCACFAHLAKAMTDYA-SSHQDMLYSPPSISYN-STLQAGLRKFAQPSG | VIHCVVSYGNMNTLNLGLWLDGDEVICPRHVIASSI-NSAIDYDHEYTMRLHNFSVSSG--- | NLFIG | | | | | | | | | | |
| <i>BtCoV512</i> | YSGSASEADYRLACFAHLAKAMSDFA-NDHMDKLYTPPTVSYN-STLQAGLRKMAQPSG | IVEGCVVSYGNMNTLNLGLWLDGDEVICPRHVIASNT-TNVIDYDHAMSLVRLHNFSISSG--- | NMFLG | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | YSGSPGEVDYRLACYAHLAHAMMSFG-KDQRDVLTPPTVSYN-STLQAGLRKMAQPSG | IVEPCVVRVSYNSTVNLGLWLDGDEVICPRHVIASNT-NAVIDYDHAYVMRLHNFSISAG--- | NIYLG | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | YSGSASEADYRLACFHLAKAMMDYG-TTHQDCLYTPPTVSYN-STLQAGLRKMAQPSG | MVEKCVVSYGNMNTLNLGLWLDGDEVICPRHVIASNT-TTLIDYDAVYHSMRLHNFSISVG--- | NVFLG | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | YSGSASEADYRLACYAHLAKAMLDYS-SNHNDILYTPPTVSYN-STLQAGLRKMAQPSG | VVERCVVSYGNMNTLNLGLWLDGDEVICPRHVIASNT-SSIIDYEHQYSVMRLHNFSISVG--- | NVFLG | | | | | | | | | | |
| <i>CDPHE15</i> | YSGGANEADYRLACFAHLAKAMMDYG-SNHQDMLYSPPTVSYN-STLQAGLRKMAQPSG | VVERCVVSYGNMNTLNLGLWLDGDEVICPRHVIASNT-TTHIDYEHALAIMRLHNFSISYG--- | NTFLG | | | | | | | | | | |
| <i>FCoV</i> | YTGSMGEADYRMACYAHLGKALMDYS-VSRNDMLYTPPTVSVN-STLQAGLRKMAQPSG | VVEPCVVRVYGNMNTLNLGLWLDGDEVICPRHVIASNT-SRVINYENELSSVRLHNFSIAKN--- | NAFLG | | | | | | | | | | |
| <i>Ferret-CoV</i> | YTGSMGEADYRMACYAHLAKALMDYG-NNRNDMLYTPPTVSVN-STLQAGLRKMAQPSG | VVEPCVVRVYGNMNTLNLGLWLDGDEVICPRHVIASNT-SKPINYDTELLGVRRLHNFSISKG--- | NDFLG | | | | | | | | | | |
| <i>HKU10</i> | YSGAASEADYRLACYAHLAKAVLDYG-TNHQDLYTPPTVSYN-STLQAGLRKMAQPSG | VVEKCVRVVYGNMNTLNLGLWLDGDEVICPRHVIASNT-NALIDYEHYIEMRLHNFSISVG--- | NVFLG | | | | | | | | | | |
| <i>HKU2</i> | YSGSANEADYRCACYAHLAKALIDFS-TTRQDLYTPPTVSYN-STLQAGLRKMAQPSG | LVVEPCVVRVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TVTIDYDAVYHSMRLHNFSISKG--- | NVFLG | | | | | | | | | | |
| <i>HKU8</i> | YSGSASEADYRCACFAHLAKALLAYA-DNHQDLYTPPTVSYN-STLQAGLRKMAQPSG | IVEKCVRVVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TNTIDYEHYIEMRLHNFSISVG--- | NVFLG | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | YSGNPNEADYRAACFAWLAKAIKDYQ-MSPQDKLYCAPTVSYN-SVLQSGFKKIAQPSG | LVVEPCVVKVYLNLYNLGLWLDGQVYAPRHVIASDV-TKIVDYDTEQNLVRSNHSISIRG--- | NSYLT | | | | | | | | | | |
| <i>Mink-CoV</i> | YTGSMGESDYRMACYAHLARALLDYS-ANRNDILYTPPTVSVN-STLQAGLRKMAQPSG | IVEPCVVRVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TKTINYESDLLGVRRLHNFSISVSKG--- | NDFLG | | | | | | | | | | |
| <i>NL63</i> | YSGSASEADYRCACYAHLAKAMLDYA-KDHNDMLYSPPTVSYN-STLQAGLRKMAQPSG | CVERCVRVVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TVLIDYDHAYSTMRLHNFSVSHN--- | GVFLG | | | | | | | | | | |
| <i>NL63-related</i> | YSGSASEADYRCACYAHLAKAMLDYA-KDHNDMLYSPPTVSYN-STLQAGLRKMAQPSG | CVERCVRVVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TSLIDYEHAYSTMRLHNFSISYN--- | GVFLG | | | | | | | | | | |
| <i>Porcine-EDV</i> | YSGSASEADYRLACFAHLAKAMMDYA-SNHNDLYTPPTVSYN-STLQAGLRKMAQPSG | VVEKCVVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TSTIDYDALSVRLHNFSISSG--- | NVFLG | | | | | | | | | | |
| <i>TGE</i> | YTGSMGEADYRMACYAHLGKALMDYS-VNRTDMLYTPPTVSYN-STLQAGLRKMAQPSG | LVVEPCVVRVYGNMNTLNLGLWLDGDEVICPRHVIASNT-TRVINYENEMSSVRLHNFSVSKN--- | NVFLG | | | | | | | | | | |



| | 4580 | 4590 | 4600 | 4610 | 4620 | 4630 | 4640 | 4650 | 4660 | 4670 | 4680 | 4690 | |
|----------------------|----------|---------|----------|-------|---------|--------|---------|--------|--------|--------|--------|---------|--------|
| <i>Bat-BCoV</i> | VVSYKMTG | SVLQLG | VQINPETP | -KYK | FVRAKPG | ATFSVL | ACYNMG | PAGVYQ | VAMRPN | HTIKGS | FNLGSC | GSVGYTL | GY-DR |
| <i>Bovine-CoV</i> | VMSYQMQ | GCMVLV | LTVTLQ | NSRTP | -KYTF | GVVQPG | ETFTVLA | AYNGKP | QGAHV | TMRS | SSYTIK | GSFLCG | SGSVGY |
| <i>Covid-19</i> | VIGHSMQ | NCVLLK | KVDTAN | PKTP | -KYKF | VRIQPG | QTFSVL | ACYN | SPSGV | YQCAMP | NPNTIK | GSFLNG | SGSVGF |
| <i>GCCDC1</i> | VTGHVME | GALLRL | TVDATN | PKTP | -AHSF | VRVSTG | QAISIL | ACYDGI | PAGVY | TCTLR | ANGTL | RAAFLC | SGSGP |
| <i>HKU1</i> | VVSYQMQ | GQCLVL | TVSLQN | PYTP | -KYTF | GNVQPG | ETFTVLA | AYNGR | PQGAH | VTMRS | SSYTIK | GSFLCG | SGSVGY |
| <i>HKU14</i> | VMSYQMQ | GCMVLV | LTVTLQ | NPRT | -KYTF | GVVQPG | ETFTVLA | AYNGR | PQGAH | VTMRS | SSFTIK | GSFLCG | SGSVGY |
| <i>HKU24</i> | VMSYQMQ | GAMLI | LTVTLQ | NTKTP | -KYTF | GNVQPG | ETFTVLA | AYNGR | PQGAH | VTMRS | SSFTIK | GSFLCG | SGSVGY |
| <i>HKU4</i> | VVAHSMV | GVLLKL | TVDVAN | PSTP | -AYTF | STVKPG | ASFVL | ACYN | KPTGV | VTVN | LRHN | STIKGS | FNLGSC |
| <i>HKU5</i> | VVGHMVG | TLLKLT | VESANP | QTP | -AYTF | TTVKPG | ASFVL | ACYN | GRPTG | VFMV | MNRQ | NSTIK | GSFLCG |
| <i>HKU9</i> | VIGHMVE | GSLKLT | VDVNPK | PKTP | -AYSF | IRVSTG | QAISIL | ACYDGL | PTGVY | TCTLR | NSNGT | MRA | SFLCG |
| <i>Hedgehog-CoV</i> | CTGHAMH | GTLLKL | TVDSAN | PETP | -AYTF | TTIKQ | SSFSV | LACYN | GRPSG | TYTV | MVRPN | STIKGS | FNLGSC |
| <i>MERS-CoV</i> | VVGHAMQ | GTLLKL | TVDVAN | PSTP | -AYTF | TTVKPG | AAFSV | LACYN | GRPTG | FTTV | MVRPN | YTIKGS | FNLGSC |
| <i>MHV</i> | VMSYQMQ | GQCLVL | TVTLQN | PNTP | -KYSF | GVVQPG | ETFTVLA | AYNGR | PQGAH | VTLRS | SHSTIK | GSFLCG | SGSVGY |
| <i>OC43</i> | VMSYQMR | GCMVLV | LTVTLQ | NSRTP | -KYTF | GVVQPG | ETFTVLA | AYNGR | PQGAH | VTMRS | SSYTIK | GSFLCG | SGSVGY |
| <i>Rat-CoV</i> | VMSYQMQ | GSLVL | TVTLQN | PNTP | -KYSF | GVVQPG | ETFTVLA | AYNGR | PQGAH | VVMRS | SHSTIK | GSFLCG | SGSVGY |
| <i>SARS-CoV</i> | VIGHSMO | NCLLRL | LKVDTS | NPKTP | -KYKF | VRIOPG | QTFSVL | ACYN | SPSGV | YQCAMP | NPNTIK | GSFLNG | SGSVGF |
| <i>229E</i> | VVGATMH | GVTLKIK | VSNMHT | P | -RHSF | RTLK | SGEG | FNIL | ACYD | GCAQ | GVFV | GNMRT | NWTIR |
| <i>Bat-CoV-1A</i> | VVSAMRG | ASLVIK | VNQNPH | TP | -KHV | FKTL | RAGD | AFNIL | ACYD | GVPS | GVYGT | ILRHN | KTI |
| <i>BtCoV512</i> | VISASMR | GTLH | IKVNQ | SNVNT | P | -NYTY | KVLK | PGDS | FNIL | ACYD | GSA | GVYGN | MRTNY |
| <i>BtMr-AlphaCoV</i> | VVSATMH | GANLH | IKVNQ | SNVHT | P | -VHSF | RIVK | PGEM | FNIL | ACYD | GT | PAGVY | SVNLR |
| <i>BtNv-AlphaCoV</i> | VVSCMRG | ALLC | IKVNQ | ANVNT | P | -NYTF | KTLK | PGDS | FNIL | ACYD | GT | PAGVY | GVNLR |
| <i>BtRf-AlphaCoV</i> | VVGVTMK | GTNLH | IKVNQ | TNVHT | P | -EHTF | KTLK | QGDS | FNIL | ACYD | GT | PAGVY | GVNLR |
| <i>CDPHE15</i> | VVGCSTK | GALLL | IKVQ | NNVHT | P | -GSY | TFR | LKPG | DSFN | ILAC | YDGT | ATGVY | GVNLR |
| <i>FCoV</i> | VVSAKYK | GVNLV | LKVNQ | VNPNT | P | -EHKF | KSVR | PGES | FNIL | ACYD | EGC | PGSVY | GVNMRS |
| <i>Ferret-CoV</i> | VIGCSYR | GVNLI | IKVSN | NTLTP | P | -KHKF | KTVK | AGES | FNIL | ACYD | GK | PNVY | GVNMRT |
| <i>HKU10</i> | VVSATMK | GANLH | IKVNQ | TNVNT | P | -EHSF | KTIK | QGES | FNIL | ACYD | GM | PSGVY | GVNMR |
| <i>HKU2</i> | VVGAVMQ | GANLVI | TVSQAN | VNT | P | -YSF | RTLK | KAGE | CFNIL | ACYD | GT | PAGVY | GVNLR |
| <i>HKU8</i> | VNGVTME | GVNLH | IKVNQ | SNPHT | P | -KHTF | RTLK | PGDS | FNIL | ACYD | GT | PAGVY | GITMR |
| <i>LuchengRn-CoV</i> | VKGRFR | EFCNVV | ISVVE | VPFT | P | -EHKF | DTL | KPGD | FNIL | ACYD | GIP | SGVY | GVNLR |
| <i>Mink-CoV</i> | VIGCSYR | GVNLV | IKVSN | VTQTP | P | -KHKF | RIVK | AGES | FNIL | ACYD | GK | PNVY | GVNMRT |
| <i>NL63</i> | VVGVTMH | GSVLR | IKVSN | VHT | P | -KHV | FKTL | KPGD | DSFN | ILAC | YEG | IAS | GVFV |
| <i>NL63-related</i> | VVGATMH | GSVLR | IKVSN | VHT | P | -KHV | FKTL | KPGD | DSFN | ILAC | YEG | VAS | GVFV |
| <i>Porcine-EDV</i> | VVSATMR | GALLQ | IKVNQ | NNVHT | P | -KYTY | RIVR | PGES | FNIL | ACYD | GAA | GVYGN | MRSNY |
| <i>TGE</i> | VVSARYK | GVNLV | LKVNQ | VNPNT | P | -EHKF | KSIK | AGES | FNIL | ACYD | EGC | PGSVY | GVNMRS |



4710 4720 4730 4740 4750 4760 4770 4780 4790 4800 4810 4820

Bat-BCoV LNVLAWLAAVINGERWFI V P Q T C A L T D F N T A V L K Y G Y Q S L T E D G V A A L D P L V A Q T G I S V Q T M C A S L K D L L V H G M R G R C I L S S P T L E D E F T P F D I V R Q C S G V T L Q S T V R S V S S K F F Q W M L M T A L T F T

Bovine-CoV VNFVAWLYAAAILNNCNWFVQSDKCSVEDFNWALSNGFSQV--KSDLVIDALASMTGVSLETLLAAIKR-LKNGFQGRQIMGSCSFEDELTPSDVYQQLAGIKLQSKRTRLVKGI V C W I M A S T F L F S

Covid-19 VNVLAWLAAVINGDRWFLNRFRTTLNDFNLVAMKYNYEPLTDQHDVLDIGPLSAQTGIAVLDMCASLKELLQNGMNGRTILGSALLEDEFTPFDDVVRQCSGVTTFQSAVKRTIKGTHHWLLLTILFSL

GCCDC1 VNVLAWLAAVLSGESWFWTKLGITAAEFNTSAVKYMCQSVTSESLOVLQPLAAKTGVSQRMLSSLKVLSTGFCGRTIMGSCSLEDEHTPYDIGRQMLGVTTLQSRTOQKRVKQWFLIVFALSC

HKU1 VNVIAWLYAAAILNNCWVQNDVCS TEDFNWAMANGFSQV--KADLVLDALASMTGVSLETLLAAIKR-LYMGFQGRQILGSCTFEDELAPSDVYQQLAGVKLQSKTKRFIKETIYWILISTFLLFS

HKU14 VNFVAWLYAAAILNNCNWFVQSDRCSI EDYNVWAMSNQFSQI--KSDLVVDALASMTGVSLENLLAAIKR-LHKGFGGRQIMGSCAFEDELTPSDVYQQLAGVKLQSKRTRVFKGTICWVIAS T F L F S

HKU24 VNFVAWLYAAAILNNCNWF IQSDICSVEDYNVWAMANGFSQF--TMDLVIDALASMTGVPVEKCLAAIKR-LNNGFQGRQILGSCVFEDELTPSDVYQQLAGVKLQSKRTRVFKGTLCWVLTSTFLLFA

HKU4 INVVAWLYAAVINGCKWFKPTRVGI VTYNEWALSNGFTEF--VGTQSIDMLAHR TGVSVEQMLLAIQS-LHAGFQGRQILGQSTLEDEFTPDVNMQVMGVVMQSGVKRISYGFHHLISTFVLLAY

HKU5 INVVAWLYAAAILNCGNWFVKPNKTGIATFNWAMSNQFTEF--IGTQSVDMLAHRTGVSVEQLLYAIQT-LHKGFGGRQILGNSMLEDEFTPDVNMQVMGVVMQSGVKRISYGLVHWFLLTLLAY

HKU9 VNVLAWLAAVLSGENWFLTKSSISPAEFNNAVKYMCQSVTSESLOVLQPLAAKTGISVERMLSALKVLLSAGFCGRTIMGSCSLEDEHTPYDIGRQMLGVKLQKGFQSMFRWTLQWFAIIFVLTII

Hedgehog-CoV INVVAWLYAAVINGCNWFVKPNKTGVAAFNWALSNGFTEF--VSTQALELLAVKTGVQIEQLLYSIQQ-LNNGFQGNVILGSAMLEDEFTPDVNMQMMGVVMQSSVRKITYGLTHWLLATCVLTY

MERS-CoV VNVVAWLYAAAILNGCAWFKPNRTSVVSNWALANQFTEF--VGTQSVDM LAVKTGVAIEQLLYAIQQ-LYTGFGQKQILGSTMLEDEFTPDVNMQIMGVVMQSGVRKVTYGTAWHLFATLVSTY

MHV VNVVAWLYAAIFNRCNWFVQSDSCSLEEFNVWAMTNGFSSI--KADLVLDALASMTGVTVEQVLAARIK-LHSGFQGRQILGSCVLEDELTPSDVYQQLAGVKLQSKRTRVFKGTCCWILASTFLLFC

OC43 VNFVAWLYAAAILNNCNWFVQSDKCSVEDFNWALSNGFSQV--KSDLVIDALASMTGVSLETLLAAIKR-LKNGFQGRQIMGSCSFEDELTPSDVYQQLAGIKLQSKRTRLFKGTVCWIMASTFLLFS

Rat-CoV VNVVAWLYAAAILNRCNWFVQSDSCSLEEFNVWAMTNGFSSI--KADLVLDALASMTGVTVEQVLAARIK-LYSGFQGRQILGSCVLEDELTPSDVYQQLSAGVKLQSKRTRVFKGTCCWILASTFLLFC

SARS-CoV LNVLAWLAAVINGDRWFLNRFRTTLNDFNLVAMKYNYEPLTDQHDVLDIGPLSAQTGIAVLDMCAALKELLONGMNGRTILGSTILEDEFTPFDDVVRQCSGVTTFQSGKFKKIVKGTTHHWMLLTFLTSL

229E VNVVAFLYAAAILNGCTWVLKGDKLSVEHYNEWAQANGFTAM--NGEDAFSILAAGTGVVERLLHAIQV-LNNGFQGRQILGYSSLNDEFSINEVVKQMFVNLQSGKTTSMFKSI---SLFAGFFV

Bat-CoV-1A VNVIAFLYGAAILNGCTWFLSNERSVAEVENGWAHDNNTFDV--GSDFCNILAAGTGVVQRI L A S I Q K - L A K G F G G R N I I G Y A S L T D E F T V S E V V K Q M Y G V S L Q S K R V P S I F N N V --- T L V S V F W S

BtCoV512 ENVCWLYGALINGDRWLLSSVSVGVDTYNEWALRNGMTAL--KNVDCFSLLVAKTGVDVGRLLASIQK-LHGNFGGKSI L G C T S L C D E F T L S E V V K Q M Y G V T L Q S G K V S R A F R N A --- S I V C C L L F

BtMr-AlphaCoV DNVVAFLYGALLNGITWVLSPSRI TVEAFNEWASVSGYPTL--QSADGYSILAAGTGV E V E R I L S S I Q K - H A N G F G G R N V L G Y S A L T D D F T L S E V V K Q M F G V N L Q S K K V S C C K S L --- L L V G G F F A

BtNv-AlphaCoV ANVVSFLYGALLNGCNWVLTSDRLTLEAFNDWATSNDFRTL--SSVDMYTI L S A K T G V D V A R V L A A I Q K - L A K G F G G K I L G Y S S L D E F T T A G E V I K Q M Y G V T L Q S S K K S R F L G N L --- L S I G L F V F

BtRf-AlphaCoV INVIAFLYGALLNGITWFLSNDRVTVESFNEWASVNGYTDG--GSIDCFAMLAAGTGVVQRI L A A V Q R - L H K G F G G K N I L G F T T L D E F T V T E V I K Q M Y G V S L Q S G K V S S M F Y N V --- C V I G A F L T

CDPHE15 ENNVAFLYGALLNGCNWVLDQCGVTVEAYNDWAHNSGCTSL--SSTDCFTILAAGTGV E V S R V L A A I Q R - L N V N F G G K A I L G Y T S L T D E F T V G E I I K Q M F G V N L Q S G I I S R S V R N V --- L L V G L F V L

FCoV DNVVAFLYAALINGERWFTNTSMTLESYNWAKTNSFTEI--VSTDAFNMLAAGTGV S V E K L L E C I V R - L N K G F G G R T I L S Y G S L C D E F T P T E V I R Q M Y G V N L Q S G K V S I F Y P M --- M T A I A I L F

Ferret-CoV DNVVAFLYAALINGERWVFSNAVALETYNWAIANGFTEL--SSADFSMLSAKTGV S V E K L L D A V M R - L S T S L G G K T I L G Y G S L S D E F T T T E V V R Q M F G V N L Q S N S V K S W F Y P I --- A I T V V C M F

HKU10 PNVIAFLYGALLNGITWVLSNDKVSVESFNEWALNNGFTTC--GNLDFNMLSAKTGV D V Q R L L A A V Q R - L H N S F G G K N I L G Y T T L D E F T V G E V I K Q M Y G V T L Q S N K V V G A F C N L --- A I V G L F V T

HKU2 ENNVAFLYAALINGERWCSNERCTIDSFNEWALNGFTNL--VSGDFGSM LAAGTGV D V Q R L L A I Q R - L A T G L G G K T I L G Y A S V T D E Y T L S E V V R Q M Y G V N I Q S T K T S S A L K N L --- F L M G F F L

HKU8 PNVVAFLYGALLNGVNVFVSPERLSVEAFNEWAHNNGFTDM--SGAECFTMLAAGTGV D V Q R V L A S I Q K - I A K S F G G R N I L G F T S L T D E F T A A E V I K Q M Y G V N L Q S R K L P S V F N N I --- M L V G V F W F

LuchengRn-CoV ENVIAFFYAALLNGERWVCSKDSVCVTNFNSWAADNHYTML--STTDVFNLVASKTGV S V E Q V L A A I I S - Y A K G F G H R T I L G Y A S I N D E Y T I T E V M Q M F G V Q L Q S R R V K V F E G F --- T L F F F F V A

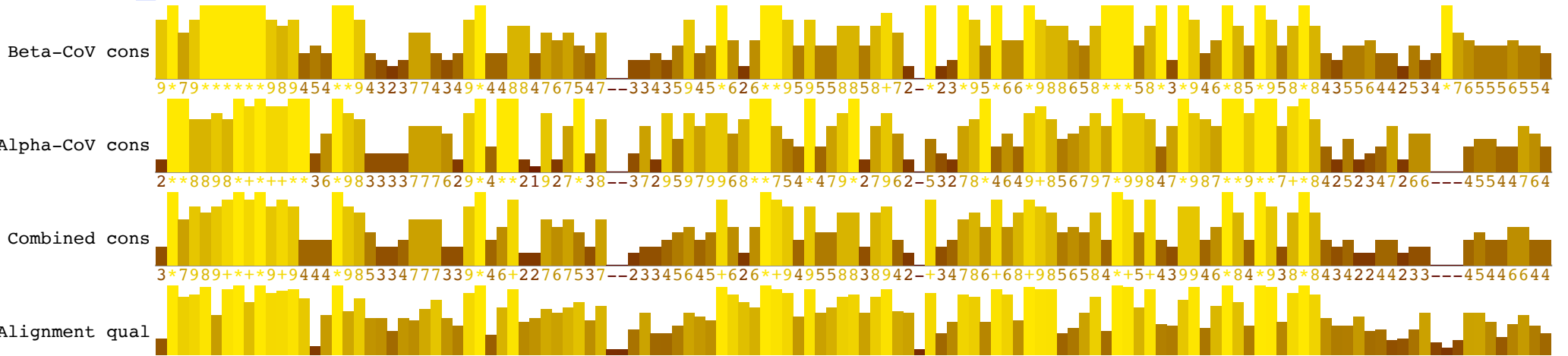
Mink-CoV DNVVAFLYAALINGERWFINSGYTSL E T F N N W A R S N G Y T E L -- A S I D V F S M L A A K T S I N V E R L L D A I M R - L S T G L G G R T I L G Y G S L S D E F T P T E V V R Q M F G V N L Q S T K V K S Y C Y P V --- L M I C A F L F

NL63 DNVVAFLYAALLNGCRWVLCSTRVNDVGFNEWAMANGYTSV--SSVECYSILAAGTGV S V E Q L L A S I Q H - L H E G F G G K N I L G Y S S L C D E F T L A E V V K Q M Y G V N L Q S G K V I F G L K T M --- F L F S V F F T

NL63-related DNVIAFMYAALLNGCRWVLRPERTNVDVFNDAVANGYTSV--SSVDCYSILAAGTGV S V E Q I L A A I Q R - L C D G F G G K T I L G Y P S L C D E F T L A E V V K Q M Y G V N L Q S G K V N S G L K T L --- L L F G V F F T

Porcine-EDV ENVLAFLYAALINGSTWVLSRSSRIAVDRFNEWAVHNGMTTV--GNTDCF S I L A A K T G V D V Q R L L A S I Q S - L H K N F G G K Q I L G H T S L T D E F T T G E V V R Q M Y G V N L Q G G Y V S R A C R N V --- L L V G S F L T

TGE DNVVAFLYAALINGERWFTNTSMLS E Y N T W A K T N S F T E L -- S S T D A F S M L A A K T G Q S V E K L L D S I V R - L N K G F G G R T I L S Y G S L C D E F T P T E V I R O M Y G V N L O A G K V S F F Y P I --- M T A M T I L F



4830 4840 4850 4860 4870 4880 4890 4900 4910 4920 4930 4940 4950

Bat-BCoV ILFLQLWEMSI FSWFAMHATIPV VILLMGVSAFV TMLVKHKHAF TTLFLMPTLAVVFY NCIIYVPEH WLIEMV-SKYVDL TDTIQLFY GYSIRELIAL -FAVVIAMSV-----LSLRIVYDD--NTRR

Bovine-CoV CIITAFVKWTFMYVTNM-LSITFCALCVISLAML LVKHKHLYL TMYIIPVLF TLLYNNYL VVYKQTFRGYV---YAWLSYYVPS-VEYTYTDEVI YGMLLLIGMVF-----VTLRSINHD--LFSF

Covid-19 LVLVQSTQWSLFFFLYENAF LPPFAMGI IAMSAFAMFVKHKHAF LCLFLP SLATVAYFNMVYMPASWVMRIM-T-WLDMVDT--SLSGFKLKDCVMY-ASAVGILLIL-----MTARTVYDD--GARR

GCCDC1 LTLHLHSQWTVL GALPLQLLLPLLG FISC VGFMAFIKHKHTFLTYVLLPVVMVAAYNFQYQPEGIQGYLL-YVYVYVNPGRFD-MGFDLTTML-----VISGITTL-----LSVRIAKSD--TYSR

HKU1 CIISAFVKWTFMYINTHM-IGVTL CVL CFV S F M L L V K H K H F L T M Y I I P V L C T L F Y V N Y L V V Y K E G F R G F T ---YVWLSYFVPA-VNFTYVYEVFYGCILCVFAIF-----ITMHSINHD--IFSL

HKU14 CIITAFVKWTFMYVTTHM-LSVTVLALCCVSFTMLLVKHKHLYL TMYIIPVLL TLLYNNYL VVYKHSFRGYV---YAWLSHFMP S-VDYTYTDEVI YSIVLLFGMIF-----ITMRSINHD--VFSV

HKU24 CILSAFVKWTFMYVT LNV-LSVTIGTLCFVACAM LFIKHKHLYL T M F I L P V F L T L Y T N Y L V V Y K Q S F R G Y A ---YAWLSYVVP S-VDYTYTYEVLYGCCAVLFMIF-----TTMRSINHD--LFSI

HKU4 VSVMQLTKFTMWTYLFETIPTQMTPLLLGFMACV MFTVKHKHTFMSLFLLPVALCLTYANIVYEPQTLISSTLIAVANWLTPTS V-YMRTHTFDFGLY-I SLSFVLAI-----IVRRLYRPS--MSNL

HKU5 VATLQ LTKFTIWN YLFEVIPLQLT PLVLCVMACV MLTVKHKHTFLTLFLLP TAICLTYANIVYEPQTPVSSALIAVANWLNPA S V-YMRTHTDLG VY-LSLCFALAV-----VVRRLYRPN--ASN L

HKU9 LILLQLAQWTFV GALPFTLLLP LIGFVA VCVGFSLLIKHKHTYLT VYLLPVAMVTAYNFQYTPPEGVQGYLL-SLYNVYVNPGRIDVIGTDLLTML-----IISVACTL-----LSVRMVRTD--AYSR

Hedgehog-CoV VVILQLTKFTIWNFLFNVIPLQLTPIMFVVLALAMLCVKHKHAF LTTFLLP GALCLTYANLVYEPNTPVSSFLIMCVNWLNP DGT-YMRTHMDLG VY-VSLCLALLV-----VVRRLYKPS--VTNC

MERS-CoV VIILQATKFTLWNYLFETIPTQLFPLFVTMAFVMLLVKHKHTFLTLFLLPVAICLTYANIVYEP TPISSALIAVANWLA PTNA-YMRTHTDIGVY-I SMSLVLVI-----VVKRLYNPS--LSNF

MHV SIISAFVKWTFMYVTTHM-LGVTLCALCFVSFAMLLIKHKHLYL TMYIMPVLC TLFYTN YLVVYKQSF RGLA---YAWLSHFVPA-VDYTYMDEVLYGVVLLVAMVF-----VTMRSINHD--VFSI

OC43 CIITAFVKWTFMYVTNM-FSITFCALCVISLAML LVKHKHLYL TMYITPVLF TLLYNNYL VVYKHTFRGYV---YAWLSYYVPS-VEYTYTDEVI YGMLLLVGMVF-----VTLRSINHD--LFSF

Rat-CoV SIIAAFVKWTFMYVTTHM-LGVTLCALCFVSFAMLLIKHKHLYL TMYIMPVLC TLFYTN YLVVYKQSF RGLA---YAWLSHFVPA-VDYTYMDEVLYGVVLLIAMVF-----VTMRSINHD--VFSI

SARS-CoV LILVOSTOWSLFFFLYENAF LPPFTLGLIMAIACAM LLVKHKHAF LCLFLP SLATVAYFNMVYMPASWVMRIM-T-WLELADT--SLSGYRLKDCVMY-ASALVLLIL-----MTARTVYDD--AARR

229E MFWAELFVYTTTIWVNPGLTPPFMILLVALSLCLTFVVKHKVLFLOVFLLP SIIVAATQNC AWDYHITK-VLA-----EKFDYNVSVMQMDIQGFVN--IFICLFVALL-----HTWRFAKER--CTHW

Bat-CoV-1A MFLSELLYTTSSYWKPD LITAVFVLLFGI AVM LTLTIKHKVLF LYTF LIPSVVISACYNLAWDLYIRE-LLA-----KYFDYHMSIFSMDIQGC FN--IVACILVNAI-----HTWRFVKTG--TATR

BtCoV512 LFLSEMLNHSKLFWINPGYITPVFLAIIVASSALMLLVKHKLLFLQLYLLPSLCIVSGYNI FKDYHFYT-YML-----EEFDYKVPFGGFNVTVGLN--ISLCCFVM--GLHTFRFLQTPN---KI

BtMr-AlphaCoV MFWGEFLMYS S V M V H P A V V T P I L L C L G L V S L M L S G L I K H K M M F L Q T F L L P S I V I A A N N F W D Y F V T Q - L L V ---QYFDYASLFSLDIQGLLN--IAMCLFVMFL-----HTYRFVSTGN---NA

BtNv-AlphaCoV MFWSEFLSY S A L F W I N A N V L T P I F L C L C G F S V V L T V G L K H K L L F L Y T F L I P T V V L L A A I N L S W D F Y L R A - L L S ---STVGYHTSLMSFDLQGLN--IAICAFVSGL-----HLYRFSPNVG---SC

BtRf-AlphaCoV MFWSELLHYTAFFWISPGFITPFFMLLMVSVFFMGLKHKIMFLYTF LIPAVIVTSCYNFAWDWYITS-VLA-----TTFDYHVSLLSLDIQGVIN--VSACVFVTL-----HTFRFCKSSVNYSSV

CDPHE15 LFWSELVIYTPFFWVSPAYITPLFLIVSGV S I L C M S L L K H K T F L Q M F L I P A V I A V S A Y N L A Y D L E I R T - W M A ---TKLDYHASILSFNIQGFN--IMVCCVVVCL-----HAYRCVTRSS---SV

FCoV AFWLEFFMYTPFTWINPTFVSVLLAITLTVSVLLVAGIKHKMLFMSFVMPSVILATAHNVVWDMTYYESLQV-----LVENVNTTFLPVD MQGVML--ALFCVVVFI-----CTIRFFTCQ---SW

Ferret-CoV AFWTEFFLYTPFSWFGPASIGCLLMTVVVSALLTIFVKHKMLYFMSFLLPSVILMTVSNLVWDSLYIAAVQA-----KLVEVNMSLIAVDMQ SVAL--MVLC LLVAIV-----HCYRFCTQRQ---SI

HKU10 MFWSELLQYTAFFWVSPGFVTPVFFALLV S F I L M C F L K H K V L F L Y T F L I P S V I M A S Y N F M W D W S V A A - E L A ---RIFDYHVSIVSFDIQGLN--VAVCLFVTL-----HTMRFFKNT---SI

HKU2 LFWSEFFMYSTILWINPGLITTFGLFVMLSMLLASC I K H K M L F L Q L F L L P S I I A A C Y N F A W D M E V T R - M L A ---TQFDYHVSFLNMDIQGAIN--IIVCFIGISL-----HTYRELDTQ---LRSY

HKU8 MFISEMLYTSSYWKEDLITPIFIIILFAIAVFLTAFVKHKVLF LYTF LIPGIVITATSNLAWDCYVRD-LLA-----KYLDYHMSIFNMDIQGVFN--IAACFMVNAL-----HTWRYMRS G--YTTR

LuchengRn-CoV LFWTQFLMYTSV S I L Q W E V I I S V L V G L T C A S A I T I V F I K H K M V F L Y G Y V P A T L V V F S N F L W D Y V V S A - I I M ---EHASFMSAYFSFDVQSVFN--IFMLSFVLIL-----HLARFYCSGGAL-IT

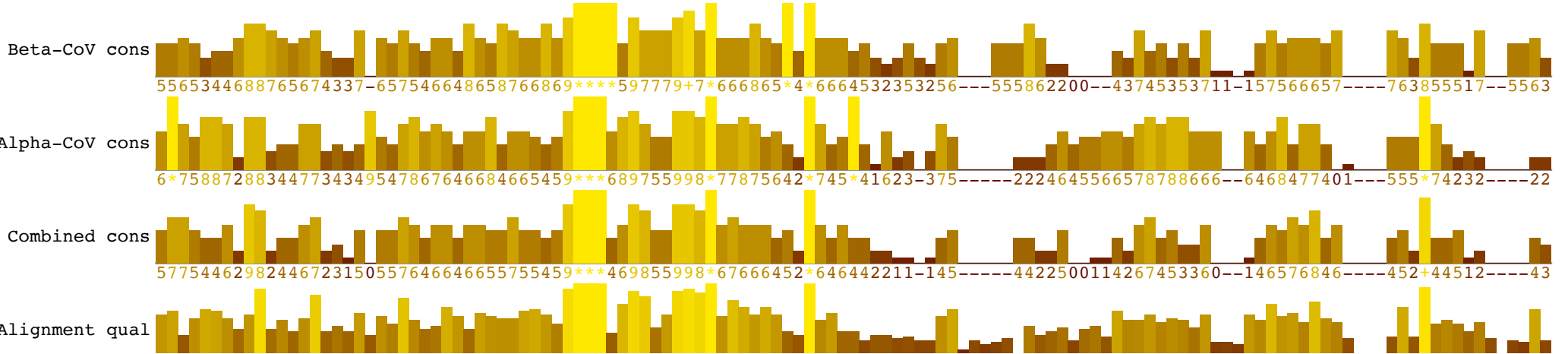
Mink-CoV AFWSEFFLYTPFTWFSPTMISCILFVTVVISAIFTTFVKHKMLYCSSFLLPSIILMTCSNLVWDYFYFEAVQA-----KLVEINLSLVSIDMQSVAL--IILCVLIACV-----HCYRFVTQKQ---SI

NL63 MFWAELFIYTN TIWNPVILTPIFC LLLF L S L V L T M F L K H K F L F L Q V F L L P T V I A T A L Y N C V L D Y Y I V K - F L A ---DHFNYNVSVLQMDVQGLVN--VLVCLFVVFL-----HTWRF SKER--FTHW

NL63-related MFWAELFIYTN TIWNPVILTPVFCILFLSLVLTMLLKHKFLFLQAFLLPTVIATALYNC AWDYMAR-FLA-----DHFNYNVSVLQMDIQGLVN--VLVCLLVAFL-----HTWRFAKER--FTHW

Porcine-EDV FFWSELVSYTKFFVNP GYVTPMFACLSLSSLLMPTLKHKTLFFQVFLIPALIVTSCINLAFDVEVYN-YLA-----EHFDYHVS LMGFN AQGLVN--IFVCFVVTILHGTYTWRFFNTPA---SS

TGE AFWLEFFMYTPFTWINPTFVSIVLAVTTLISTVFSVGIKHKMLFMSFVLPSVILVTAHNLFWDFSYESLOS-----IVENTNTMFLPVD MQGVML--TVFCFIVFVT-----YSVRFFTCKO---SW



4960 4970 4980 4990 5000 5010 5020 5030 5040 5050 5060 5070

Bat-BCoV VWLATNVLTWLYRLYA-----GTTVEK-AMAYWALLMSLTNTNYSGCVTVIMFAAKGVTTLLIYYQ-FPFLGLLIAEFKFLMLVYTCIGYLCCVYGGIFCMLNKY----LRCTFGVYPYLVS

Bovine-CoV IMFVGRVISVVSLSWYM-----GSNLEE---EILLMLASLFGTYTWTTALSMAAAKVIKVVAVN--VLYFTDIPQIKIVLVCYLFYGIYIISCYWGLFSLMNSL----FRMPLGVYNYKISV

Covid-19 VWTLMNVLTLVYKVYY-----GNALDQ-AISMWALIIISVTSNYSQVVTVMFLARGIVFMCVEY-CPIFFITGNTLQICIMLVYCFGLGYFCTCYFGLFCLLNRY----FRLTLGVYDYLVS

GCCDC1 WYVYCTAIGWVYNCCT-----GTAETI-ALSYLTFVVSFTNYTGVCASLYAAQFMVWVWLKFL-DPTILLYGRFRCVLCVYLLVGYLCTCYFGVFNLLNRL----FRCTLGTYDYVVS

HKU1 MFLVGRIVTLISMWYF-----GSNLEE---DVLLFITAFGLTYTWTTILSLAIKIVANWLSVN--IFYFTDVPYIKLILLSYLFYGIYILSCYWGFFSLLNSV----FRMPMGVYNYKISV

HKU14 IMFAGRIVISTVSMWYI-----GSNLEE---EVLILLVSAFGTYTWTTVLSLAVSKIIAKWISVN--LLYFTDIPLIKLVLLSYLFVGYVVSVCYWGGLFSLMNSL----FRMPLGVYNYKISV

HKU24 IIFITRVSSVSMWYM-----GSNLEI---EILLLVSIFGTYTWTTIISLTVAKAMAWLHAN--IFYLTDIPHVKILLMCYLLVGYIVCCYWGVSFLCNKL----FRVPLGVYNYKISV

HKU4 ALALCSGVMWFYTYVI-----GDH-SS-PITYLMFITLTSYDITITVFATVNLAKFISGLVFFY-APHLGFILPEVKLVLLIYGLGYMCTMYFGVFSLLNLK----LRVPLGVYDYSVST

HKU5 ALALGSAMVWFYTYTT-----GDC-SS-PLTYLMFLTTLTSYDITVTVFLAVNVAKFFARVVFLY-APHAGFIFPEVKLVLLYLAAGVYFCTVYFGVFSLLNLK----LRVPLGVYDYSVST

HKU9 IWYVCTAVGWLYNCWT-----GSADTV-AISYLTVMVSVFTNYTGVCASLYAAQFMVWVWLKFL-DPTILLYGRFRCVLCVYLLVGYLCTCYFGVFNLLNRL----FRCTLGNIEYVVS

Hedgehog-CoV AFALTSLVMMWFYSYSI-----GDA-SS-PIVYLQFVTAATSQYDVTMVTFLAVNVAKCLTYLTSY-FTTLLSVVPEVKIVLLMYICIGFICTMYFGVFSFLNLK----MRAPMGVYSYEVST

MERS-CoV ALALCSGVMWLYTYSI-----GEA-SS-PIAYLVFVTTLTSYDITITVFVTVNLAKVCTYAIKAY-SPQLTLVFPPEVKMILLYTCGLGFMCTCYFGVFSLLNLK----LRAPMGVYDFKVST

MHV MFLVGRVLSLVSMWYF-----GANLEE---EVLFLFTSLFGTYTWTTMLSATAKVIKWLAVN--VLYFTDVPQIKLVLLSYLCIGYVCCCYWGLSLLNSI----FRMPLGVYNYKISV

OC43 IMFVGRVLSVFSLSWYK-----GSNLEE---EILLMLASLFGTYTWTTVLSMAVAKVIKVVAVN--VLYFTDIPQIKIVLVCYLFYGIYIISCYWGLFSLMNSL----FRMPLGVYNYKISV

Rat-CoV MFLVGRVLSLVSMWYF-----GANLEE---EVLFLFTSLFGTYTWTTMLSATAKVIKWLAVN--VLYFTDVPQIKLVLLSYLCIGYVCCCYWGLSLLNSI----FRMPLGVYNYKISV

SARS-CoV VWTLMNVITLVYKVYY-----GNALDQ-AISMWALVTSVTSNYSQVVTTIMFLARAIVFVCEY-YPLLFITGNTLQICIMLVYCFGLGYCCCYFGLFCLLNRY----FRLTLGVYDYLVS

229E CTYLFSLIAVLYTALY-----SYDYVSLVLLMLLCAISNEWYIGAIIFRRCR---FGVAFL-PVEYVSYFDGVTVLLFYMLLGFVSCMYYGLLYWINRF----CKCTLGVYDFCVSP

Bat-CoV-1a LTYVLSLVSVVYNYWC-----CGDFLSLMMVLLNINNNWYIGAIAYRFSV---VVVNYM-DPSVIRMLGGVKVILFMVTCGYLCCMYGICYWFNRF----FKCTMGLYEFKVSP

BtCoV512 FSYYVAVLTVLYTYYY-----STDVGLILTSMSGFTNYWFIGTATYKLAT---YVLP-H-T-SLLDSFDAIKAVVFLYLLLYGNCVYYSGLYWINRF----CKLTLGCYEFKVSA

BtMr-AlphaCoV IAYLSSLVVSAYTYLL-----GGDPYCAIMVLCSLSEWYVAVCYKLA---RIAPYT-SPIIATVFGTPKVIIVVYALGYFTCVYWGFLYVFNRF----FKFTLGEYDFKVSP

BtNv-AlphaCoV ATLLMSLGVTVYNYWF-----DTDYFSIIMTLLNMSSTWYIGAIAYKIAS---VMIVFV-PAPLIAAFGPIKTVLMVYVVCIGYVFCMYWGCYWLNLRV----SKLTLGVYDFKVSS

BtRf-AlphaCoV ITYCCSLLFVAYGFYM-----GSDALSLVMMVLFNFTSNWYVGAIVYKIAF---YTRDMT---VLPVLLVGNVAVMVCYIVLGYFCCVYYGILYWINRF----FKLTLGVYDFKVSA

CDPHE15 FTMVVACVTSCYSYVI-----CGDALSAAMAIMLNTGNWVFGAGAYRLAT---YIVLLN-P-ALPALVGDVKAIVFVYVAVGYVCCVYFGILYWVNRF----CKLSLGVYDFMVSP

FCoV FSLFATTFVFMFNIVKLLGM-IGEPWTDHFLCLVNMLTMLISLTKDWVVFVASYKVA---YIVVYMQPAFVQDFGVKCVSIIYMACGYLFCYVYGGILYWVNRF----TCMTCGVYQFTVSP

Ferret-CoV PVFVVTLCFVFNFAQWYVYLRGLDMGVNLQFGYVNLGMMVLVCLMTKDWIVVAVAYRVAY---YIVLYILSPDVVDFGLLKLCCVYMLLGYCSCCYVGVLYWVNRF----THMTCGVYQFAVSA

HKU10 STYVLSLAFTVYGFVV-----GSDVLSIVMTLLFNLTSSWYVGAIVYKLA---YLQYYT---SFAQILGSIKAIMLCYMLGGLYLCVYVYGGFLYWINRF----CKLSLGVYDFKVSA

HKU2 STYVLSMCTVLYTFYY-----GYDSLAIIMLLGFCREWYVGTAAFLAQ---FIVPYC-P-GLISFVGDIAKAVLVLVYVFGFVATVYFGLYVWLNLRV----LKLTLGVYDFKVSA

HKU8 VTYVASLIVSVNYWY-----VGDALSLAMLLLNVNNNWYIGACAYRFV---IVANYM-NPAVIGFLGSFKVIMFLYVAVGYLCCIIYVYGGILYWLNKF----FKCTLGVYDFKVSA

LuchengRn-CoV CLFSCAYTVGLFMYFV-----KIDVLSAFFMFISGIQCSWAITWSSYKIAV---YAMSYV-SPYYIEVFGYTKVLMVLYLCMGYLFVYVYGGILYWVNRF---TMNMFMSCLGYDYCVSQ

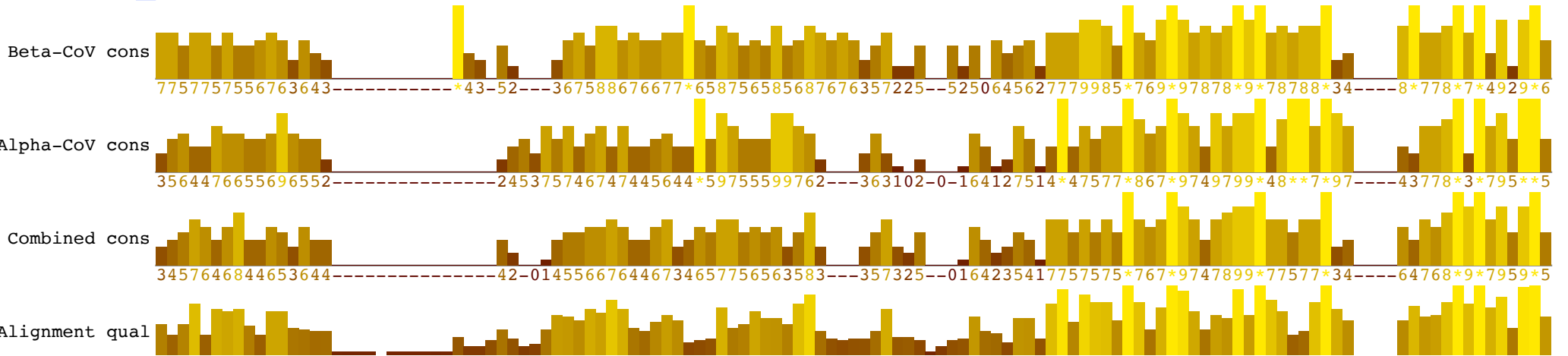
Mink-CoV PVCLITLCFVCYNLVQWYVYLLRSSDVGVNLQFGYINLGMVVVCLITKDWVVVAVAYRLAY---YTVFYLIPEQVDFGVVYKCLCVYMLFGYVSCCYVGVLYWVNRF----THMTCGVYQFAVSA

NL63 FTYVCSLIAVAYTYFY-----SGDFLSLLVMFLCAISSDWYIGAIIVFRLSR---LIVFFS-PESVFSVFGDVKLTLLVYVYLCGYLVCTYWGILYWVNRF----FKCTMGVYDFKVSA

NL63-related CTYVCSLIAVYTYFY-----SGDFLSLLVMFLCAISNEWYIGAIIFRRLR---LLVLCV-SEDIVDFGEVKTLLVYVYLCGYLVCTYWGILYWVNRF----FKCTMGVYDFKVSA

Porcine-EDV VTYVVALLTAAVNYFY-----ASDILSCAMTLFASVTGNWVFGVAVCYKVA---YMLARF-P-TFVAIFGDIKSMVFCYLVLYGYFTCCFYGILYWVNRF----FKVSLGVYDVTVSA

TGE FSLAVTTLIVIFNMVIFGT-SDEPWTENOIAFCFVNMLTMIVSLTKDWVVIASVRIAY---YIVVCVMPSAFVSDFGFMKCSIVYMACGYLFCYVYGGILYWVNRF----TCMTCGVYQFTVSA



5090 5100 5110 5120 5130 5140 5150 5160 5170 5180 5190 5200

Bat-BCoV QEFRYMNSQGLTPPTNSWDALKMNIKLSGVGGVPCIKVSNVQSKMSDIKCTSVVLLSVLQQLRIEANSRIWLSLVCVTLHNDILLAKDATEAFEKLTLLSVLLSMPGAVD-----LTKLCDDVFENP

Bovine-CoV QELRYMNANGLRPPKNSFEALMLNFKLLGIGGVPIIEVSQFQSKLTDVKCANVVLLNCLQHLHVASNSKLWQYCVSTLHNEILATSDLVGVAFEKLAQLLIVLFANPAAVDSKCLTSIEEVCCDYAKDN

Covid-19 QEFRYMNSQGLLPPKNSIDAFKLNKLLGIGGVKPCIKVATVQSKMSDVKCTSVVLLSVLQQLRVESSSKLWAOVCVQLHNDILLAKDTTEAFEKMSVLLSVLLSMQAVD-----INKLCEMLDNR

GCCDC1 QELRYMNSNGLSPPTNSWQAMVNLKLAGIGGVPMYKVATIQSNMTDLKCTSVVLLSVLQQLHVESSSKLWAOVCVQLHNEILAAKSTTEAFEAFVSLLSVLLSLPGAIN-----LDELCSILENN

HKU1 QELRYMNANGLRPPRNSFEAILLNLKLLGIGGVPIIEVSIQSKLTDVKCANVVLLNCLQHLHVASNSKLWQYCVSLHNEILSTSDLSVAFDKLAQLLIVLFANPAAVDTKCLASIDEVSDDYVQDS

HKU14 QELRYMNANGLRPPRNSFEALMLNFKLLGIGGVPIIEVSIQSKLTDVKCANVVLLNCLQHLHVASNSKLWQYCVSTLHNEILATSDLSVAFDKLAQLLIVLFANPAAVDSKCLSSIEEVCCDYAKDN

HKU24 QELRYMNANGLRPPRNSFEALILNFKLIGIGGVPIIEVSIQSKLTDVKCANVVLLNCLQHLHVASNSKLWQYCVSTLHNEILATSDLVGVAFEKLAQLLIVLFANPAAVDTKCLTSIEDVCCDYVVRDN

HKU4 QEFRFLTGNLHAPRNSWEALILNFKLLGIGGTPCIKVATVQSKLTDLKTSTVLLSVLQQLHLEANSKAWSYCVKLHNEILAAVDPTEAFERFVCLFATLMSFSANVD-----LDALANDLFENS

HKU5 QEFRYLTGNLHAPRNSWEALRLNFKLIGIGGTPCIKIASVQSKLTDLKTSTVLLSVLQQLHLEANSKAWAHCVKLHNEILAAVDPTEAFDNFVCLFATLMSFSANVD-----LEALASDLLDHP

HKU9 QELRYMNSHGLLPPPTNSWQALMLNKLKLAGIGGPIIYRVSTIQSNMTDLKCTSVVLLSVLQQLRVESSSKLWALCVKLHNEILASNSPTEAFEAFVSLLSVLLSLPGAIN-----LDELCSILENN

Hedgehog-CoV QEFRYMNANGLRAPRNSWDAMVNLNFKLLGIGGVPCIKIASVQSKLTDLKTSTVLLSVLQQLHLEANSKAWSHCVKLHNDILSTSDPSEAFEKFAVLLATLMSFSGSVD-----LEALASELLDNI

MERS-CoV QEFRFMTANLNTAPRNSWEAMALNFKLIGIGGTPCIKVAAMQSKLTDLKTSTVLLSVLQQLHLEANSRAWAFVCKCHNDILAATDPSEAFEKFAVSLFATLMTFSGNVD-----LDALASDIFDTP

MHV QELRYMNANGLRPPRNSFEALMLNFKLLGIGGVPIIEVSIQSKLTDVKCANVVLLNCLQHLHIASNSKLWQYCVSTLHNEILATSDLSVAFDKLAQLLIVLFANPAAVDSKCLASIEEVSDDYVVRDN

OC43 QELRYMNANGLRPPKNSFEALMLNFKLLGIGGVPIIEVSQFQSKLTDVKCANVVLLNCLQHLHVASNSKLWHYCVSTLHNEILATSDLSVAFDKLAQLLIVLFANPAAVDSKCLTSIEEVCCDYAKDN

Rat-CoV QELRYMNANGLRPPKNSFEALVNLNFKLIGIGGVPIIEVSIQSKLTDVKCANVVLLNCLQHLHVASNSKLWQYCVSTLHNEILATSDLSVAFDKLAQLLIVLFANPAAVDSKCLASIEEVSDDYVVRDN

SARS-CoV QEFRYMNSQGLLPPKSSIDAFKLNKLLGIGGKPCIKVATVQSKMSDVKCTSVVLLSVLQQLRVESSSKLWAOVCVOLHNDILLAKDTTEAFEKMSVLLSVLLSMQAVD-----INRLCEMLDNR

229E AEFKYMVANGLNAPNGPFDALFSLFKLMGIGGPRTIKVSTVQSKLTDLKTSTVLLMGLISNMNIAANSKEWAYCVEMHNKINLCDDPEAQELLLALLAFFLSKHSDFG-----LGDLDVDSYFEND

Bat-CoV-1a AEFKYMVANDLRAPTGVFDSMSLSLKLMLGGERTIKISTVQSKLTDIKCTNVVLMGCLSSMNIANSKKSVCVDLHNKINLCDDAEKAMEYLLALVTFFISEHADFN-----VSELVDSYFGDN

BtCoV512 AEFKYMVANGLRAPTGVFDALILSLKLGIVGGRKTIKISSVQSKLTDLKTSTVLLGCLSNMNIANSREWAYCVDLHNKINLCNDAAEQEMLLALLAFFLSKNSAFG-----VDELSDSYFNDS

BtMr-AlphaCoV AEFKYMVANNLSAPRGPFDLALSRLRVGGVQRTIRISTVQSKLTDLKCANVLLGCLSSMNIANSKDWYCVTLHNKINLCDDPEKAHEMLLALLAFFLSKQQAQF-----IDGLVDSYFDSN

BtNv-AlphaCoV AEFKYMVANGLSAPRSVLDLTYLSFKLLGIGGERTIKVATVQSKLTDLKCANVLLGCLSNMNIANSREWAYCVDLHNKINLCDDPEKAQEMLLALLAFFLSKQKDFG-----VDDLIDSYFNS

BtRf-AlphaCoV NEFKYMVANGLHAPRGVFDALVALSVKLGIGGKTIKVSTVQSKLTDIKCTNVVLLGCLSSMNIASHTKESYCVLHNKINLCDDPEKAQEMLLALLAFFLSKQKDFG-----VDDLIDSYFSSG

CDPHE15 AEFKYMVANGLRAPTGFADSLFSLARLLGIGGQRTIKISTVQSKLTDVKCTNVVLMGCLSSMNIQANSAEWNYCVDLHNKINLCNDLERAQEYLLALLAFFLSKNSAFG-----LDDLSDSYFDNN

FCoV AELKYMANNLSAPKTAYDAMILSFKLMGIGGGRNIIKISTVQSKLTEMKCTNVVLLGCLSKMHVESNSKEWNYCVGLHNEINLCDDPDAVLEKLLALIAFFLSKHNTCD-----LSDLIDSYFENT

Ferret-CoV AELKYMANNLNTAPRNAYDAMVLSKLVGIGGGRNIIKIASVQSKLTDKCTNVVLLGCLSKMHIEANSKEWNYCVNLHNEINLSDSDVVLNKLALLAFFLSKHNCD-----LSELIDSYFDNP

HKU10 NEFKFMVANGLQAPRGVFDLALSIKLMGIGGKTIKVSSVQSKLTDIKCTNVVLLGCLSSMNIANTKESYCVDLHNKINLCNDPEAAQEMLLALLAFFLSKHKDFG-----FDDLSDSYFADN

HKU2 AEFKYMVANGYTAPRGPFDVLLSLRLLGVGGQTKIVSTVQSKLTDLKCANVLLGCLSNMNIANSREWAYCVNLHNEINLSDPEALEKLLALVAFFLSKQQNF-----VDDLIDSYFENR

HKU8 AEFKYMVANDLRAPCGVFDLALLSFRMLGIGGKTIKISTVQSKLTEIKCTNVVLMGVLTSMNIEANSKDWAFVCLHNKINLSTDAEKAMEYLLALLTFFLSRQKDFN-----CTELSDSYFADS

LuchengRn-CoV AEFKYMVANNLKPTNPMEALYLNKLMGVGGPKIKLSTIQSKLTDLKTSTVLLSCLSSMNVAVNSKEWYCVQLHNDINLCDDPEKATEKLLALCSFFLSKQQNF-----LDALIDSYFDNK

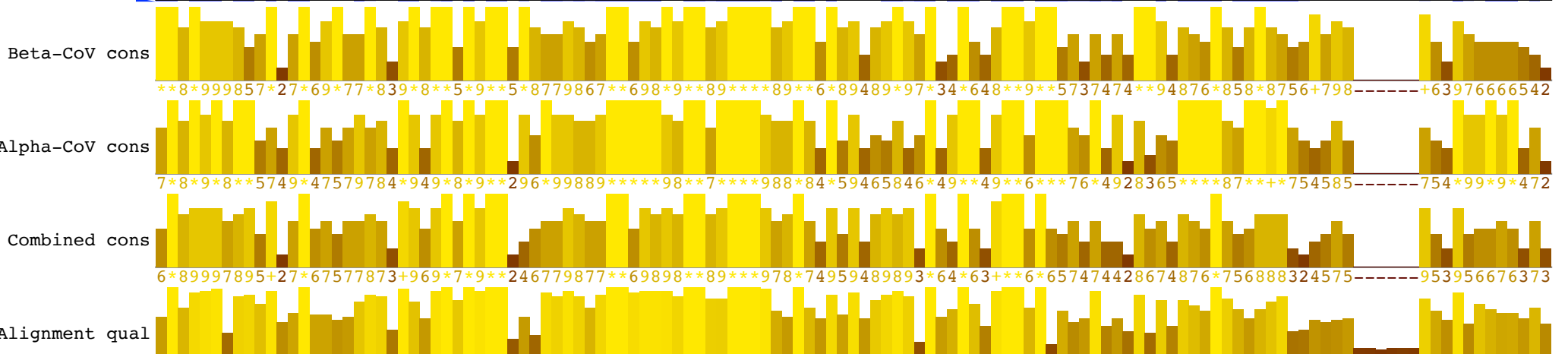
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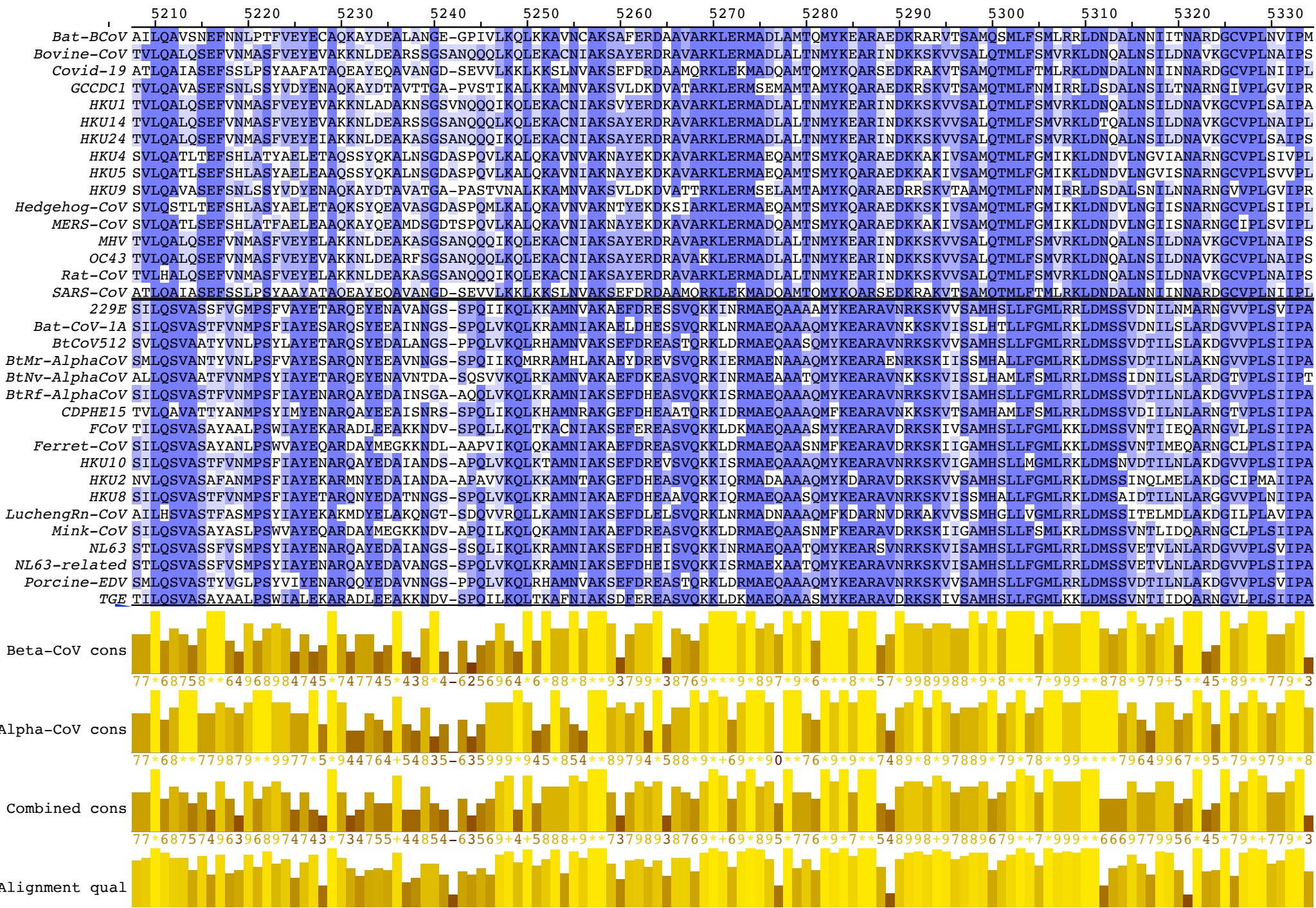
NL63 AEFKYMVANGLHAPGPFADLWLSFKLLGIGGDRCIKISTVQSKLTDLKTSTVLLGCLSSMNIANSSEWAYCVDLHNKINLCDDPEKAQSMALLAFFLSKHSDFG-----LDGLIDSYFDNS

NL63-related AEFKYMVANGLRAPQGFADLWLSFKLLGIGGDRCIKISTVQSKLTDLKTSTVLLGCLSSMNIANSSEWAYCVDLHNKINLCDDPEKAQEMLLALLAFFLSKHSDFG-----LDGLIDSYFDNS

Porcine-EDV AEFKYMVANGLRAPTGLDSSLKLAGIGGGRNIIKISSVQSKLTDIKCTNVVLLGCLSSMNVANSREWAYCVDLHNKINLCNDPEKAQEMLLALLAFFLSKNSAFG-----LDDLIDSYFDND

TGE AELKYMANNLSAPKNAYDAMILSAKLVGIGGKRNIIKISTVQSKLTEMKCTNVVLLGCLSKMHVESNSKEWNYCVGLHNEINLCDDPEIVLEKLLALIAFFLSKHNTCD-----LSELIDSYFENT





5340 5350 5360 5370 5380 5390 5400 5410 5420 5430 5440 5450 5460

Bat-BCoV LASSKLLIVVPDISVYNNNTVEGTLTYAGAVVDVQVTDADNKPIAMGDIITDITAPTLAWPLVLSAVRR--VSATKLQNNELAP-QLLNQKAVTGGSEQNIC-DQPALAYNTVQGGKHVILAVVSDH

Bovine-CoV LAANTLTIIVPKSVYDQVVDNVVYTYAGNVWQIQTIQSDGNTKQLNEIS----DDCNWPLVIAANRHNEVSATVLQNNELMP-AKLKTQVNVNSGPDQ-TCNT-PTQCYNNNSNNGKIVYAILSDV

Covid-19 TTAAKLMVVIPDYNKYKNTCDGTTFTYAGSALWEIQQVVDADSKIVQLSEISMDNSPNLAWPLIVTALRA--NSAVKLQNNELSP-VALRQMSCAAGTTQACTDDNALAYNNTKGGRFVLAISDL

GCCDC1 TAANKLLLVPDYSVFSSTVVLPTLYAGSAWDVTVQSDADGKVNVDITRENSVNLAWPLVITAVRQVATSPVKLQNNELMP-QAVKRMAVTAGISQTSCTT-DTVAYYNASKEGRHVMAILADV

HKU1 LAANTLTIIVPKQVFDKVVVDNVVYTYAGSVWHIQTVQDADGINKQLTDIS----VDSNWPLVIAANRYNEVANAVMQNNELMP-HKLKIQVNVNSGSDM-NCNI-PTQCYNNNGSSGRIVYAVLSDV

HKU14 LTANTLTIIVPKQVFDQVVDNVVYVAYAGNVWHIQSQDADGNTKQLNEIS----EDSNWPLVIVANRHNEVSQAVLQNNELMP-AKLRTQIVNSGSDM-NCNT-PTQCYNNNSNTGRIIYAILSDV

HKU24 LTANSLTIIVPKTVYDQVVDNVYIAYAGNVWHIQSIQDADGTVKQLNEIN----ESVNWPIVVTATRYNEVSTTVMQNNELMP-AKLKTQVNVSSGSDM-NCNV-PTQCYNNNSNNGRIIYAILSDT

HKU4 CASNKLRVVIPDISVWNVVWNPVSVYAGSLWDITVINNVQDNEVVKPTDVT-ETNESLWPLVIECSRS-SSSAVKLQNNELMP-IHP-KGLKTMVITAGVDQVNCNS-SAVAYEYEPVQGRHVMGILSEN

HKU5 CASNKLRVVIPDITVWNVVWNPVSVYAGSLWDITVINNVQDNEVVKPTDVT-ETNESLWPLVIECSRS-SSSAVKLQNNELMP-IHP-KGLKTMVITAGVDQVNCNS-SAVAYEYEPVQGRHVMGILSEN

HKU9 TAANKLLLVPDYSVYATITMPTLYAGSAWDVTVQSDADGKTVNATDITRENSVNLAWPLVITAVRQVATSPVKLQNNELMP-QTVKRMNVVAGVSTACVT-DAVAYYNATKEGRHVMAILADT

Hedgehog-CoV CASNKLRVVIPDMQIWKQVVTYPVLSYAGALWDITLINNVQDNEVVRPSDVI-DTNEGLWPLVLECTRA-VASAVKLQNNELMP-IKP-TGLKTMVVAAGQEQNSCTV-KSVAYEYEPVQGRHVMGILSED

MERS-CoV CASNKLRVVIPDFTVWNVVWNPVSVYAGSLWDITVINNVQDNEVVKPTDVT-ETNESLWPLVIECSRS-SSSAVKLQNNELMP-IHP-KGLKTMVITAGVDQVNCNS-SAVAYEYEPVQGRHVMGILSEN

MHV LTSNTLTIIVPKQVFDQVVDNVVYTYAGNVWHIQFIQDADGAVKQLNEID----VNSTWPLVIAANRHNEVSTVVLQNNELMP-QKLRTQVNVNSGSDM-NCNT-PTQCYNNNTGTGKIVYAILSDC

OC43 LAANTLNIIVPKSVYDQVVDNVVYTYAGNVWQIQTIQSDGNTKQLNEIS----DDCNWPLVIAANRYNEVSATVLQNNELMP-AKLKIQVNVNSGPDQ-TCNT-PTQCYNNNSNNGKIVYAILSDV

Rat-CoV LTSNTLTIIVPKQVFDQVVDNVVYTYAGNVWHIQFIQDADGAVKQLNEID----VNSIWLPLVIAANRHNEVSTVVLQNNELMP-QKLRTQVNVNSGSDM-NCNT-PTQCYNNNTGTGKIVYAILSDC

SARS-CoV TTAAKLMVVVPDYGTYKNTCDGNTFTYAGSALWEIQQVVDADSKIVOLSEINMDNSPNLAWPLIVTALRA--NSAVKLQNNELSP-VALRQMSCAAGTTQACTDDNALAYNNTKGGRFVLAISDL

229E TSAARLVVVVPDHDSEFVKMMVDGFVHYAGVWVTLQEVKDNQDGNVHLKVDVTKENQEIILVWPLILTCEV-----VKLQNNELMP-GMKVKATKGE--GDGGIISEGNALYNNEGGRAFMYAVVTTK

Bat-CoV-1A ACATKLTIVVSDFEFVKRIFQLGNVQYAGVWVSLTEVKDNDGKPVHKEITANN-TALTWPLILNCERI-----VKLQNNELMP-GKLKVRPLKGE--GEGGFTADGKALFNNEGGKTFMYAFIADK

BtCoV512 VSATKLNIVVSDIESYSKIQREGCVHYAGVIVSVVDIKDNDGKPVHAKVVTSNVESLAWPLFLNCERI-----IKLQNNELMP-SKIKQRPIKAE--GE-GVVADGNALYSNEGGRTFMAYAFISDK

BtMr-AlphaCoV TSATRLCVVCPDHEAYAKIFGQCLHYAGVWVNIQVVDNDGKTVHKEIVKANEETLSWPLSINCERI-----VKLQNNELMP-SGKLGKQAVKAD--GD-GFSSEGIALYNNEGGKTFMYAFLADK

BtNv-AlphaCoV ACATKLTIVVSDIESFVKVVDNVVYAGVWVNIQVVDNDGKTVHKEIVKANEETLSWPLSINCERI-----VKLQNNELMP-SGKLGKQAVKAE--GE-GVHCDGKALYNNEGGKTFMYAFLADK

BtRf-AlphaCoV ASATKLNIVVSDIESYKICKEGCVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GFSADGKALYNNEGGKTFMYAFLADK

CDPHE15 LCATRLSIIIVSDFEYAKLFRGCIHYAGTIWVADIKNDGKPVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

FCoV ASATRLIVVTPNLEVLKSKVRQENNVHYAGVIVVSDIESYKICKEGCVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

Ferret-CoV ASATRLVVVTPNIEVFSKIRLDNNVHYAGVIVVSDIESYKICKEGCVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

HKU10 ACSTKLNIVVSDIESYKICRQDGVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

HKU2 AAATKLTIVITPDLESFVKIRVDNVIYAGVWVNIQVVDNDGKTVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

HKU8 ACATKLVVVASDHEFSFTRVYQQAVHYAGVWVTLSEVVDNDGKPVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

LuchengRn-CoV AASNRLIVVTPSIEAFDKIRHDNSICYAGAAWAITAKVDGTTVQLAEVCSNNDKTLNWLPHIEAERV-----VKLQNNELMP-GKLSQRVNTD--C-----GTGKALYCNEQKGFIVYALLADS

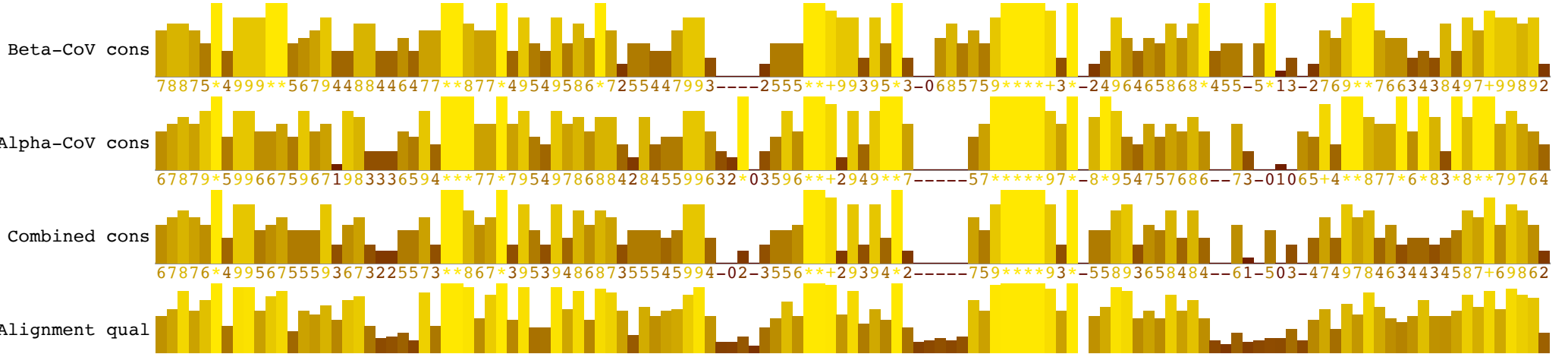
Mink-CoV ASATRLVVVTPNIDVFSKVRLENNVHYAGVIVVSDIESYKICKEGCVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

NL63 TSASKLTIVSPDLESYSKIVCDGSHYAGVWVTLNDVKDNDGRPVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

NL63-related TSASKLTIVSPDLESYSKIVCDGSHYAGVWVTLNDVKDNDGRPVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

Porcine-EDV VSATKLNIVTSDIDSYNRIQREGCVHYAGTIWNIQVVDNDGKTVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK

TGE ASATRLVVITPSLEVFSKIROENNVHYAGVIVVSDIESYKICKEGCVHYAGVIVWVIDIRDNDGKLVHKEVTVQENVENLAWPLFLNCERI-----VKLQNNELMP-GKLKQAVKAE--GD-GVMAEGKALYNTEGGRTFMAYAFIADK



5470 5480 5490 5500 5510 5520 5530 5540 5550 5560 5570 5580

Bat-BCoV DGLRWTRVDKSDGNGI^{MI}ELDPPCRF^{IT}QTSSGP-KVKYLYFIKGLN^{NL}CRGMVLGTVAA^{TV}RLQAGK^{PT}EVAANS^{KL}TLFC^{AF}AVDPE^{KAY}FD^{FN}VS^{GG}QPL^{NN}CV^{RV}LV^{LT}HT^{GT}GRA^{IT}AD^{PE}A

Bovine-CoV DGLKYTKILKDDGN-FV^{LE}ELDPPCK^{FT}VQDV^{KGL}-KIKYLYFVKGC^{NT}LARG^{WV}VT^{IS}TV^{RL}QAG^{TATE}YAS^{NS}IL^{SL}CAF^{SVD}PK^{KTY}LDF^{IQ}GG^{TP}IAN^{CV}KML^{CD}HAG^{TGM}AIT^{VK}PD^A

Covid-19 QDLKWARF^{PK}SDGT^{GT}IY^{TE}LEPP^{CR}FV^{TD}TP^{KGP}-KVKYLYFIKGLN^{NL}NRGM^{VL}GL^{SL}AAT^{VR}LQAG^{NATE}VPAN^{SV}LS^{FC}AF^{AVD}AA^{KAY}KDY^{LA}SG^{GG}Q^{PI}TNC^{VK}ML^{CT}HT^{GT}GO^{AI}TVT^{PE}A

GCCDC1 DGLLYAKVEKSTGDGF^{VILE}LEPP^{CF}MI^{ET}PK^{GP}-ALKYLYFTKGLN^{LC}RG^{TV}L^{GAL}ACT^{VR}LH^{AG}SATE^{VP}ANS^{AIL}SL^{CAF}SVD^{PE}AT^{YK}DY^{LD}NG^{GG}TP^{IG}NC^{VK}MLTHGT^{GL}L^{AT}AK^{PD}A

HKU1 DGLKYTKIMKDDGN-CV^{LE}ELDPPCK^{FS}IQDV^{KGL}-KIKYLYFIKGC^{NT}LARG^{WV}VT^{LS}TI^{RL}QAG^{VATE}YA^{ANS}IL^{SL}CAF^{SVD}PK^{KTY}L^{DI}Y^{IQ}GG^{VPI}INC^{VK}ML^{CD}HAG^{TGM}AIT^{IK}PE^A

HKU14 DGLKYTKIVKEDGN-CV^{LE}ELDPPCK^{FT}VQDA^{KGL}-KVKYLYFVKGC^{NT}LARG^{WV}VT^{IS}TV^{RL}QAG^{TATE}YAS^{NS}IL^{SL}CAF^{SVD}PK^{KTY}LDF^{IQ}GG^{API}INC^{VK}ML^{CD}HAG^{TGM}AIT^{VK}PE^A

HKU24 DGLKYTKIVKEDQS-VV^{LE}ELDPPCK^{FT}VQDA^{KGL}-KVKYLYFVKGC^{NT}LARG^{WV}VT^{IS}TV^{RL}QAG^{HATE}YA^{ANS}AIL^{SL}CAF^{SVD}PK^{KTY}L^{DI}Y^{IQ}GG^{IP}IAN^{CV}KML^{CD}HAG^{TGM}AIT^{VK}PD^A

HKU4 AHLK^{WAK}VEGK--DGF^{IN}IEL^{QPP}CK^{FL}IAG^{PK}GP-E^{IR}YLYFV^{KN}LN^{NL}HR^{GQL}LGH^{IA}AT^{VR}LQAG^{ANTE}FAS^{NS}TV^{LT}V^{AF}AV^{DP}AK^{AY}L^{DY}V^{GS}GG^{TP}LS^{NY}V^{KML}AP^{KT}GT^{GV}AI^{SV}KPE^A

HKU5 AHL^{KWAK}VEGR--DGF^{VN}IEL^{QPP}CK^{FL}IAG^{PK}GP-E^{VR}YLYFV^{KN}LN^{NL}HR^{GQL}LGH^{IA}AT^{VR}LQAG^{ANTE}F^{AIN}SV^{LS}AV^{TFS}V^{DP}G^{KAY}L^{DF}V^NAG^{GL}PL^{TNC}V^{KML}TP^{KT}GT^{GL}AI^{TV}KPE^A

HKU9 DGLAF^{AK}VEKSTGDGF^{VILE}LEPP^{CF}MI^{ET}PK^{GP}-ALKYLYFTKGLN^{LC}RG^{TV}L^{GAL}ACT^{VR}LH^{AG}SATE^{VP}ANS^{AIL}SL^{CAF}SVD^{PE}AT^{YK}DY^{LD}NG^{GG}TP^{IG}NC^{VK}MLTHGT^{GL}L^{AT}AK^{PD}A

Hedgehog-CoV AHL^{KWAR}VEGQ--DGF^{IT}IEL^{QPP}CK^{FL}IAG^{SK}GP-E^{VR}YLYFV^{KN}LN^{NL}HR^{GQL}LGH^{IA}AT^{VR}LQAG^{SNT}EYAS^{NS}SV^{LS}LV^{NF}AV^{DP}AK^{AY}T^{DY}V^NAG^{GL}PL^{TNC}V^{KML}TP^{KT}GT^{GL}AI^{SV}KPE^S

MERS-CoV AY^{LKWAR}VEGK--DGF^VS^{VEL}QPP^{CK}FL^{IAG}PK^{GP}-E^{IR}YLYFV^{KN}LN^{NL}HR^{GQL}LGH^{IA}AT^{VR}LQAG^{SNT}EYAS^{NS}SV^{LS}LV^{NF}T^{VD}P^{QAY}L^{DF}V^NAG^{GL}PL^{TNC}V^{KML}TP^{KT}GT^{GL}AI^{SV}KPE^S

MHV DGLKYTKIVKEDGN-CV^{LE}ELDPPCK^{FS}VQDV^{KGL}-KIKYLYFVKGC^{NT}LARG^{WV}VT^{LS}TI^{RL}QAG^{TATE}YAS^{NS}AIL^{SL}CAF^{SVD}PK^{KTY}L^{DI}Y^{IK}GG^{VPT}NC^{VK}ML^{CD}HAG^{TGM}AIT^{IK}PE^A

OC43 DGLKYTKILKDDGN-FV^{LE}ELDPPCK^{FT}VQDA^{KGL}-KIKYLYFVKGC^{NT}LARG^{WV}VT^{IS}TV^{RL}QAG^{TATE}YAS^{NS}IL^{SL}CAF^{SVD}PK^{KTY}LDF^{IQ}GG^{TP}IAN^{CV}KML^{CD}HAG^{TGM}AIT^{VK}PD^A

Rat-CoV DGLKYTKIVKEDGN-CV^{LE}ELDPPCK^{FS}VQDV^{KGL}-KIKYLYFVKGC^{NT}LARG^{WV}VT^{LS}TI^{RL}QAG^{TATE}YAS^{NS}AIL^{SL}CAF^{SVD}PK^{KTY}L^{DI}Y^{IQ}GG^{VPT}NC^{VK}ML^{CD}HAG^{TGM}AIT^{IK}PE^A

SARS-CoV QDLKWARF^{PK}SDGT^{GT}IY^{TE}LEPP^{CR}FV^{TD}TP^{KGP}-KVKYLYFIKGLN^{NL}NRGM^{VL}GL^{SL}AAT^{VR}LQAG^{NATE}VPAN^{SV}LS^{FC}AF^{AVD}PA^{KAY}KDY^{LA}SG^{GG}Q^{PI}TNC^{VK}ML^{CT}HT^{GT}GO^{AI}TVT^{PE}A

229E PGMKYV^{KWE}HDSG--V^{VT}VELEPP^{CR}FV^{ID}TP^{TGP}-Q^{IK}YLYFV^{KN}LN^{NL}RR^{GAV}LG^{YI}GAT^{VR}LQAG^{KQ}TE^{FV}SN^{SH}LLTHCAF^{AVD}PA^{AY}L^{DAV}K^QAK^{PV}GN^{CV}KML^{TNG}SG^{SG}QAI^TST^{IDS}

Bat-CoV-1a PDLK^{VVK}W^EFDGG--CN^{VIE}LEPP^{CR}FA^{VD}DAG^{NN}V^{KY}LYFV^{KN}LN^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KQ}TE^{LV}NS^{SL}TL^{CS}FA^{VD}PA^{KY}CL^{DAV}K^{SV}K^{PV}NC^{VK}ML^{SNG}SG^{TG}QAV^{TV}GV^EA

BtCoV512 PDLK^{VVK}W^EFDGG--SN^{AI}ELEPP^{CK}FL^{VE}AP^{SGP}-V^{VK}YLYF^{VR}NL^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KQ}TE^{QA}TNS^{SL}TL^{CA}FA^{VD}PK^{TY}L^{DAV}K^{SG}HR^{PV}GN^{CV}KML^{ANG}SG^{NG}QAI^TNG^{VE}A

BtMr-AlphaCoV PDLK^{VVR}W^EFDGG--CN^{VIE}LEPP^{RR}FA^{VE}TG^{SGT}-Q^{IK}YLYFV^{KN}LN^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KQ}TE^{QA}ANS^{SL}TLTMCA^{FA}VD^{PA}KY^{CL}DA^{VK}GG^{VK}PV^{GN}CI^{KML}SN^{GS}SG^{NG}QAI^TNG^{VE}S

BtNv-AlphaCoV PDLK^{YVK}W^DFDGG--CN^{VIE}LEPP^{CK}FA^{VE}TG^{TV}-Q^{VR}YLYFV^{KN}LN^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{KQ}TE^{LA}TNS^{SL}TL^{CA}FA^{VD}PK^{MY}IDS^{VK}AG^{IK}PV^{GN}CV^{KML}SN^{GAG}NG^{QAI}TT^SVE^A

BtRf-AlphaCoV PDLK^{YVK}W^EFDGG--CN^{TIE}LEPP^{CK}FA^{VE}ST^{NGT}-V^{IK}YLYF^{VR}NL^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KQ}TE^{LA}TNS^{PL}TLTMCA^{FS}V^{DP}AK^{TY}L^{DAV}K^{RG}V^{KP}V^{GN}CI^{KML}SN^{GAG}TG^{QAI}TV^{GV}ES

CDPHE15 PDLK^{VVK}W^ESDDG--VK^{VIE}LEPP^{CK}FL^{VD}TP^{NGP}-H^{VK}F^{LY}F^{VR}NL^{NL}LR^{GA}VL^{GF}V^{GAT}VR^{LQ}AG^{KQ}TE^{QV}MNS^{SL}TLTMCA^{FS}T^{DP}AK^{TY}L^{DAV}K^{SV}K^PI^{GN}CV^{KML}AN^{GAG}NG^{QAI}TV^{GV}ES

FCoV SNL^{KYV}K^WESNND--V^{IP}IELE^{AP}LR^{FY}V^DGV^{NGP}-E^{VK}YLYF^{VK}SL^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{KP}TE^{HPS}NS^{GL}TL^{CA}FA^{PD}PA^{KAY}V^{DAV}K^{RM}Q^{PVT}NC^{VK}ML^{SNG}AG^{NG}MA^{IT}NG^{VE}S

Ferret-CoV GN^{LKYV}K^WE^GNSD--V^{IT}IELE^QPL^{RF}V^DGP^{NGP}-E^{VK}H^{LY}F^{VK}NL^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{KQ}TE^{HPS}NS^{SL}TL^{CA}FA^{PE}PA^{KAY}VE^LV^{KR}GM^{QPV}NC^{VK}ML^{SNG}SG^{NG}MA^{IT}NG^{VE}A

HKU10 PDLK^{FVK}W^EFDNG--CS^{VIE}LEPP^{CR}FA^{VT}PT^{TGT}-T^{IK}YLYF^{VR}NL^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KQ}TE^{LA}VNS^{PL}TLTMCA^{FA}VD^{PA}KY^{TL}DA^{VK}RG^{AK}PV^{GN}CI^{KML}AN^GSG^{TG}QAV^{TV}TV^{GV}E

HKU2 PDLK^{VVK}W^{EY}DGG--CK^{TIE}LEPP^{LF}FA^{VE}AP^{TGV}-Q^{IK}YLYF^{VK}NL^{NL}LR^{GA}T^{LG}Y^IGAT^{VR}LQAG^{KQ}TE^{LA}CNS^{SL}TL^{CA}FA^{VD}PA^{KAY}V^{SAV}K^{GAK}PV^{GN}CV^{KML}AN^GSG^{TG}QAV^{TV}NG^{VE}A

HKU8 PDLK^{VVK}W^EFEGG--RN^{TIE}LEPP^{CF}AV^{SN}SG^TTS^{IK}YLYF^{VK}NL^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{TQ}TE^{LV}ANS^{SL}TLTMCS^{FA}VD^{PR}KY^{CL}DA^{VK}NG^{VK}PV^{TNC}V^{KML}SN^GSG^{TG}QAV^{TV}GV^EA

LuchengRn-CoV PD^{ITY}IK^WD^NGLD--DM^{VIE}LEK^{PV}K^FS^{VQ}SP^{NGP}-Q^{IK}YLYF^{VK}NL^{NL}LR^{GA}VL^{GF}I^{GAT}VR^{LQ}AG^{KP}TE^{YA}TDC^{QL}TL^{CA}FA^{VD}PK^{DAY}L^{TAV}R^QGH^{KP}LS^{NC}I^{KMI}NG^{SG}NG^{LAI}TH^RVE^A

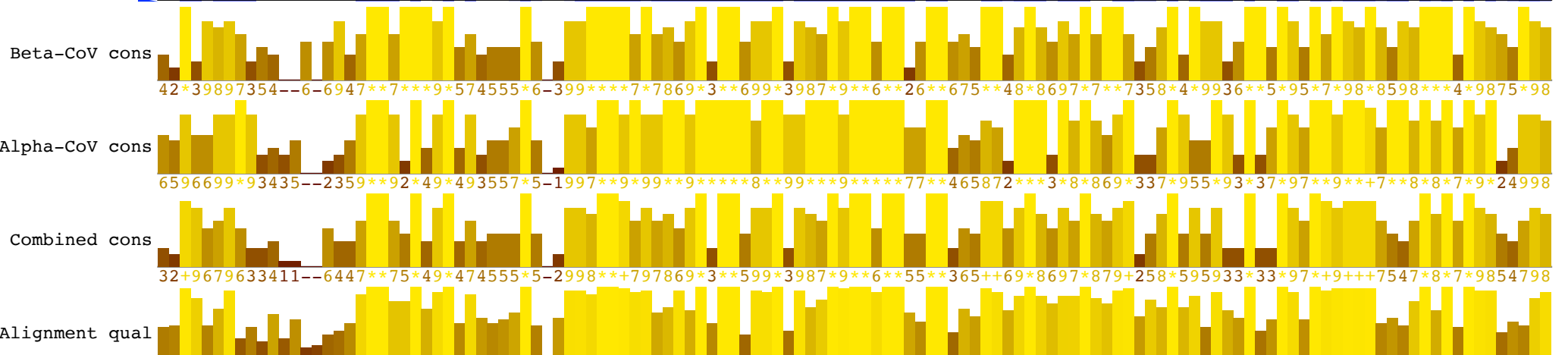
Mink-CoV GN^{LKYV}K^WE^GNND--V^{IT}IELE^QPL^{KF}V^YEG^{ANGP}-E^{IK}H^{LY}F^{VK}NL^{NL}LR^{GA}VL^{GY}I^{GAT}IR^{LQ}AG^{KQ}TE^{HPS}NS^{SL}TL^{CA}FA^{PE}PA^{KAY}VE^LV^{KR}GM^{QPV}NC^{VK}ML^{SNG}SG^{NG}MA^{IT}NG^{VE}A

NL63 ADL^{KFV}K^WEY^EGG--CN^{TIE}LD^{SP}CR^{FM}V^{ET}PN^{GP}-Q^{VK}YLYF^{VK}NL^{NL}LR^{GA}VL^{GF}I^{GAT}IR^{LQ}AG^{KQ}TE^{LA}VNS^{GL}TL^{TA}CA^{FS}V^{DP}AT^{TY}LE^{AV}K^{HG}AK^{PV}SN^{CI}I^{KML}SN^{GAG}NG^{QAI}TT^SV^{DA}

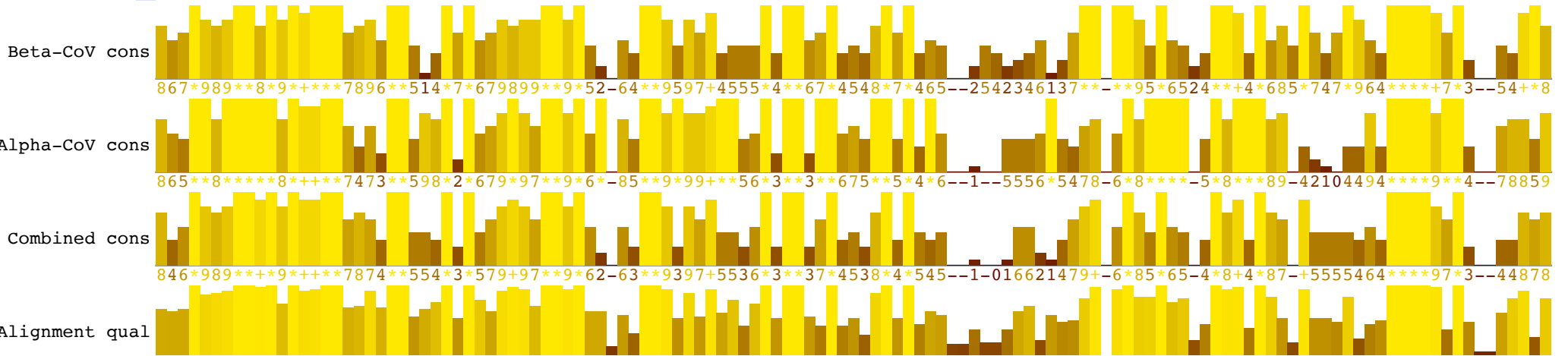
NL63-related ADL^{KFV}K^WEY^EGG--CN^{TIE}LD^{SP}CR^{FM}V^{ET}PN^{GP}-Q^{VK}YLYF^{VK}NL^{NL}LR^{GA}VL^{GF}I^{GAT}IR^{LQ}AG^{KQ}TE^{LA}VNS^{GL}TL^{TA}CA^{FS}V^{DP}AS^TYLE^{AV}K^{HG}AK^{PV}GN^{CI}I^{KML}SN^{GAG}NG^{QAI}TT^SV^{DA}

Porcine-EDV PDL^RV^{VK}W^EFDGG--CN^{TIE}LEPP^{RF}LV^DSP^{NGA}-Q^{IK}YLYF^{VR}NL^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{KQ}TE^{QA}INS^{SL}TL^{CA}FA^{VD}PA^{KTY}I^{DAV}K^{SGH}K^{PV}GN^{CV}KML^{AN}G^{SG}NG^{QAV}TV^{NG}VE^A

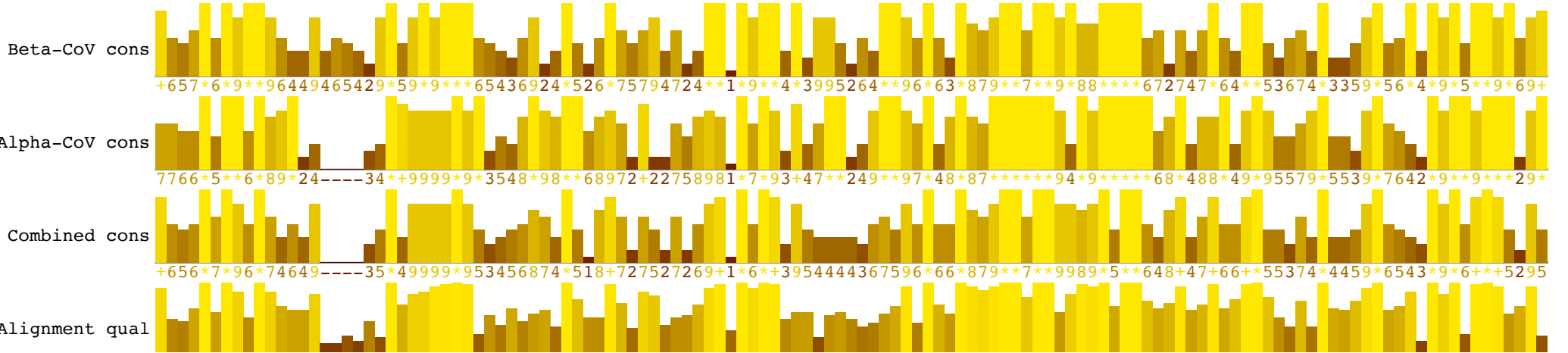
TGE NNL^{KYV}K^WESNND--I^{PI}IELE^{AP}LR^{FY}V^DGA^{NGP}-E^{VK}YLYF^{VK}NL^{NL}LR^{GA}VL^{GY}I^{GAT}VR^{LQ}AG^{KP}TE^{HPS}NS^{SL}TL^{CA}FA^{SP}PA^{KAY}V^{DAV}K^{RM}Q^{PVT}NC^{VK}ML^{SNG}AG^{NG}MA^{IT}NG^{VE}A



| | 5590 | 5600 | 5610 | 5620 | 5630 | 5640 | 5650 | 5660 | 5670 | 5680 | 5690 | 5700 | 5710 |
|----------------------|--|---|------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | TADQESYGGSSCCLYCRCHISHPSHNGLCKYKGGKYVQIPNVCTNDPVGFLLKNTVNCNVACWIGYGCNCDTLRQPVLHAAD-DSFL | NRVRGVS-AARLTPCGSGLSTDVAVVRAFDLYNS--KIGGF | | | | | | | | | | | |
| <i>Bovine-CoV</i> | TTNQDSYGGASVCIYCRARVEHPDVGDLCKLRGKRVQVPLG-IKDPVSYVLTHTDVCQVCGFWRDGCSCVST--DTTVQSKDTNFL | NRVVRTSVDARLVPCASGLSTDVQLRAFDICNA--SVAGI | | | | | | | | | | | |
| <i>Covid-19</i> | NMDQESFSGGASCCLYCRCHIDHPNPKGFCDLKGGKYVQIPTTCANDPVGFLLKNTVCTVCGMWWKGYGSCDQLREPMLOSADAQSFL | NRVCGVS-AARLTPCGTGSTDVVYRAFDIYND--KVAGF | | | | | | | | | | | |
| <i>GCCDC1</i> | SIDQESFSGGASCCLYCRCHIEHPGASGVCKFKGKRVQIPLVGVNDPIGFICIRNVCAVCNMWQGYGCPSSLREINLQARD-ECFL | NRVVGASGVARLVFPQIGVQVDPVLRADFICNA--KVAGF | | | | | | | | | | | |
| <i>HKU1</i> | TINQDSYGGASVCIYCRARVEHPDVGDLCKLRGKRVQVPLG-IKDPILYVLTHTDVCQVCGFWRDGCSCVGS--SVAVQSKDLNFL | NRVVRTSVNARLVPCASGLSTDVQLRAFDICNT--NRAGI | | | | | | | | | | | |
| <i>HKU14</i> | TTSQDSYGGASVCIYCRARIEHPDVGDLCKLRGKRVQVPLG-IKDPVSYVLTHTDVCQVCGFWRDGCSCVST--GAFVQSKDTNFL | NRVVGASVDARLVPCATGLSTDVQLRAFDICNA--SVAGI | | | | | | | | | | | |
| <i>HKU24</i> | TTNQDSYGGASVCIYCRARIEHPDVGDLCKLRGKRVQVPLG-IKDPVSYVLTHTDVCQVCGFWRDGCSCVGS--SATLQSKDTNFL | NRVVGASVDARLVPCASGLSTDVQKRAFDICNA--NVAGI | | | | | | | | | | | |
| <i>HKU4</i> | TADQETYGGASVCLYCRAHIEHPDVGCVCKYKTRFVQIPAH-VRDPVGFLLKNTVNCNVQYVWVGYGCNCDALRNNTVPQSKDTNFL | NRVVGSSVNARLEPCSSGLTDDVYRAFDICNFKARVAGI | | | | | | | | | | | |
| <i>HKU5</i> | NADQDITYGGASVCLYCRAHIEHPDVTGVCKFKGKRVQVPLH-IRDPVGFCLQNTVPCNVQFVWGHGNCNCDALRGTTPQSKDSNFL | NRVVGSIVNARIEPCASGLTDDVYRAFDICNYKAVAGI | | | | | | | | | | | |
| <i>HKU9</i> | NIDQESFSGGASCCLYCRCHIEHPGASGVCKYKGGKYVQIPLVGVNDPIGFICIRNVCAVCNMWQGYGCPSSLREINLQARD-ECFL | NRVVRTSGVARLVPLGSGVQPDIVLRAFDICNT--KVAGF | | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | NLDQETYGGASVCLYCRAHIEHPDVGCVCKFKGKRVQIPAQCTRDVGFCLANVQCNVCQYVWVGYGCNCDLRENTMLHSHKDTNFL | NRVVGSIVDARIEPCASGLATDVYRAFDICNYKARVAGI | | | | | | | | | | | |
| <i>MERS-CoV</i> | TADQETYGGASVCLYCRAHIEHPDVGCVCKYKGGKYVQIPAQCVRPVGFCLSNTPCNVCQYVWVGYGCNCDLRLQAALPQSKDSNFL | NRVVGSIVNARIEPCSSGLSTDVYRAFDICNYKAVAGI | | | | | | | | | | | |
| <i>MHV</i> | TTNQDSYGGASVCIYCRSRVEHPDVGDLCKLRGKRVQVPLG-IKDPVSYVLTHTDVCQVCGFWRDGCSCVGT--GSQFQSKDTNFL | NRIRGTSVNARLVPCASGLSTDVQLRAFDICNA--NRAGI | | | | | | | | | | | |
| <i>OC43</i> | TTSQDSYGGASVCIYCRARVEHPDVGDLCKLRGKRVQVPLG-IKDPVSYVLTHTDVCVCGFWRDGCSCVST--DTTVQSKDTNFL | NRVVRTSVDARLVPCASGLSTDVQLRAFDIYNA--SVAGI | | | | | | | | | | | |
| <i>Rat-CoV</i> | TTNQDSYGGASVCIYCRSRVEHPDVGDLCKLRGKRVQVPLG-IKDPVLYVLTHTDVCQVCGFWRDGCSCVGT--GSQFQSKDTNFL | NRVVRTSVNARLVPCASGLSTDVQLRAFDICNA--NRAGI | | | | | | | | | | | |
| <i>SARS-CoV</i> | NMDQESFSGGASCCLYCRCHIDHPNPKGFCDLKGGKYVQIPTTCANDPVGFLLKNTVCTVCGMWWKGYGSCDQLREPMLOSADASTFL | NRVCGVS-AARLTPCGTGSTDVVYRAFDIYNE--KVAGF | | | | | | | | | | | |
| <i>229E</i> | NTTQDITYGGASVCIYCRAHVAHPTMDGFCQYKGGKVVQVPIG-TNDPIRFCLNTVCKVCGCWLNHGCTCDRT--A--IQSFDSSYL | NRVVGSS-AARLEPCN-GTDIDYCVRAFDVYNK--DASFI | | | | | | | | | | | |
| <i>Bat-CoV-1A</i> | NTNQDSYGGASVCLYCRAHVDHPSIDGFCQFKGRYVQIPVG-TVDPPIRFCLNQVCKVCHCWLNNGCSCGRT--S-VIQSVDQAYL | NRARGSS-AARLEPCN-GTEPEHVRAFDIYNK--EVASI | | | | | | | | | | | |
| <i>BtCoV512</i> | STNQDSYGGASVCLYCRAHVEHPDMDGFCCKLRGKYVQVPLG-TLDPPIRFVLENTVCKVCGCQWANGCTCDRA---VIQSVDSGYL | NRVVGSS-AARLEPLN-GSDTHHVRAFDVYNR--DVACI | | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | NTSQDITYGGASVCLYCRAHVDHPSMDGFCRLKGGYVQVPLG-TLDPPIRYCLENTVCKVACWLNNGCQCERT--S--MQSFDNGYL | NRVVGSS-DARLEPLN-GTDIDRCVRAFDVYNK--DVACI | | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | NTNQDSYGGASVCIYCRAHVEHPMDGRCQFKGRYVQVPLG-TADPIRFCLNKVCSVCGCWLNNGCSCDRS--S--LQAVDTAYL | NRVVGSS-AARLEPCN-GSETDHCVRAFDIYNK--DVACI | | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | NTNQDSYGGASVCLYCRAHVEHPSMDGRCRLKGGYVQVPLG-TIDPIRFCLENDTCKVCMWLNNGCTCDRV--S-SVQAFDAGYL | NRARGSS-AAQLEPCN-GTDTDHCVRAFDIYNK--EVACM | | | | | | | | | | | |
| <i>CDPHE15</i> | NTSQDSYGGASVCLWCRAVVEHPAMDGFCYKRGKYVQVPIG-TVDPPIRYCLENEVCKVCGCWLNNGCSCDRT--S-IVQSFDSYSL | NRARGSS-AARLEPCN-GTDTDHYVRAFDIYNK--DVACI | | | | | | | | | | | |
| <i>FCoV</i> | NTQDQDSYGGASVCIYCRCHVEHPAIDGLCRFKGKRVQVPTG-TQDPIRFCEIENEVCVCGCWLNNGCSCDRT--SIQGTIDQSYL | NRVVGSS-AARLEPCN-GTDPDHSVRAFDIYNK--DVACI | | | | | | | | | | | |
| <i>Ferret-CoV</i> | TPNQDSYGGASVCIYCRSHTAHPSLDGFRCFRKGVQVPTG-TVDPPIRFCEIENEVCVACWLNNGCVCRT--SMQAQVVDQSYL | NRVVGSS-GARLEPCN-GTNPDCVTRAFDVYNA--DVACI | | | | | | | | | | | |
| <i>HKU10</i> | NTNQDSYGGASVCLYCRAHVEHPSMDGYCKLRGKYVQVPMG-TIDPIRFVLENEACKVCCWLNNGCACDRV--STSMQAFDNGYL | NRARGSS-AAQLEPCN-GTDTDHCVRAFDIYNK--DVACL | | | | | | | | | | | |
| <i>HKU2</i> | NMNQDSYGGASVCIYCRAHVDHPAMDGACRFKGGYVQVPIG-VNDPIRFCEIENEVCVCGCWLNNGCSCDRS--S--VQSTDQAYL | NRARGSS-AARLEPCN-GTEPEHCVRAFDVYNK--DVACI | | | | | | | | | | | |
| <i>HKU8</i> | NTNQDSYGGASVCLYCRAHIDHPSMDGFCQFKGRYVQVPLG-TVDPPIRYCLENDICKVCHCWLNNGCTCDRT--T-VVQSLDNNYL | NRVVGSS-AARLEPCN-GTEPEHVIRAFDIYNK--DVACI | | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | NTVQDSYGGASCCLYCRASVEHPGMNGICNLRGKYVQVPTG-TTDPVRFVLENEVCSVCSWLGHGCVCDRS--SVQSAIIDQGYL | NRVVGSS-DAQLEPCS-E---HHVRAFDIYNK--DVSCI | | | | | | | | | | | |
| <i>Mink-CoV</i> | TPNQDSYGGASVCIYCRSHTAHPSIDGMRFRKGVQVPTG-TADPIRFCEIENDICVACWLNNGCVCRT--SMQAQVVDQELF | KRVVGSS-GARLEPCN-GTSPDCVTRAFDVYNA--DVACI | | | | | | | | | | | |
| <i>NL63</i> | NTNQDSYGGASVCIYCRAHVPHPSMDGYCKFKGKCVQVPIG-CLDPIRFCLENNVCNVCGCWLGHGACDRT--T--IQSVDISYL | NRARGSS-AARLEPCN-GTDIDKCVRAFDIYNK--NVSFL | | | | | | | | | | | |
| <i>NL63-related</i> | NTNQDSYGGASVCLYCRAHVSHPSMDGYCKFKGKCVQVPLG-CMDPIRFCLNKVCTVCGCWLGHGCSCDRT--T--VQSFDMYSYL | NRARGSS-AARLEPCN-GTDIDKCVRAFDIYNK--NVAFL | | | | | | | | | | | |
| <i>Porcine-EDV</i> | STNQDSYGGASVCLYCRAHVEHPSMDGFCRLKGGYVQVPLG-TVDPPIRFVLENDVCKVCGCWLNNGCTCDRS---IMQSTDMAYL | NRVVGSS-AARLEPCN-GTDTQHVVRAFDIYNK--DVACL | | | | | | | | | | | |
| <i>TGE</i> | NTQDQDSYGGASVCIYCRCHVEHPAIDGLCRYKGGKRVQVPTG-TQDPIRFCEIENEVCVCGCWLNNGCMCDRT--SMQSFVTDOSYLFKRVVGSS | AARLEPCN-GTDPDHSVRAFDIYNK--DVACI | | | | | | | | | | | |



| | 5720 | 5730 | 5740 | 5750 | 5760 | 5770 | 5780 | 5790 | 5800 | 5810 | 5820 | 5830 | 5840 | | | | |
|----------------------|----------------|--------------|--------------|------------------|-----------------|-------------------|----------------|---------------|--------------|-------------|-------------|----------|----------|----------|------------|-------------|-------------|
| <i>Bat-BCoV</i> | GLRYKGNCCRFQEI | DEDGKALDSFFI | VKRHTEDNFKLE | QEMYDLLKDSGVVAVH | DFHFVRVEGRMEPHI | TRQRLTKYTMADLVYAF | RHFDENSCEVLKEI | LVTYNCCGSDYFE | EKKDWYDFVENP | DIL | | | | | | | |
| <i>Bovine-CoV</i> | GLHLKVNCCRFQ | RVDENGDKLDQ | FFVVKRTDLTI | YNREMECYERVK | DKCFVAEHDFTF | DVEGSRVPHIVR | KDLTKYTMLDLCY | ALRHFDRNDCML | CDILSIYAGCEQ | SYFTKKDWYDF | VENPDI | | | | | | |
| <i>Covid-19</i> | AKFLKTNCCRFQ | EKDEDDNLIDS | YFVVKRHTFSNY | QHEETIYNLLKDC | PAVAKHDFKFR | FRIDGMVPHISR | QRLTKYTMADLVY | ALRHFDEGNCD | TLKEILVTYNC | DDDYFNKKDWY | DFVENP | | | | | | |
| <i>GCCDC1</i> | GLHLKNNCCRYQ | EQLDSEGNKLD | SFVVKRHTESNY | ALEQRCYDKLKD | CVVARHDFFKF | KVEGVMTPHISR | QRLTKYTMADLVY | SLRHFDRNDC | ILKEILVMRG | CDEEFFTKKDW | DFVETPELI | | | | | | |
| <i>HKU1</i> | GLYYKVNCCRFQ | RIDDDGNKLD | KFFVVKRNTLEV | YNKEKTYEELTK | SCGVVAEHDFTF | IDGSRVPHIVRR | NLSKYTMDLDCY | ALRHFDRNDC | SILCEILCEY | ADKESYFSKKD | WYDFVENP | | | | | | |
| <i>HKU14</i> | GLHLKVNCCRFQ | RLEDSEGNKMD | RFVVKRTDLVT | YNREMECYERV | KGCRVVAEHDF | TFAVEGSRVPHI | VRKDLTKYTML | DLCYALRHFDR | NDCSLLCDIL | SMYAGCEQSY | FTQKDWYDF | VENPDI | | | | | |
| <i>HKU24</i> | GLHYKVNCCRFQ | CAEEDGTLDD | QYFVVKRTGLD | YDKEKACYERL | KDCSVVAVHDF | TFDVEGSRVPHI | VRKYLTKYTML | DLCYALRHFDR | NDCSLLCDIL | CLYAECEQSY | FTKKDWYDF | VENPDI | | | | | |
| <i>HKU4</i> | GKYYKTNTCRFV | QVDEDEGHKLD | SFYIVKRHTMS | NYELEKRCYDLL | KDCDAVAIHDF | IFDVKVTKTPH | IVRQSLTEYTM | MDLVYALRHF | DQNNCEVLKS | ILVKYGCCEQ | SYFDNKLWF | DFVENPSV | | | | | |
| <i>HKU5</i> | GKYYKTNTCRFV | EVDEDEGHRL | DSFYVVKRHTM | ENYELKRCYDL | KDCDAVAIHDF | IFDVKVTKTPH | IVRQSLTEYTM | MDLVYALRHF | DQNNCEVLKS | ILVKYGCCEQ | SYFDNKLWF | DFVENPNI | | | | | |
| <i>HKU9</i> | GLHLKNNCCRYQ | EQLDADGTQL | DSYFVVKRHTS | NYLLEQRCYEKL | KDCGVVARHDF | FKFNIEGVMTPH | VSRRERLTKYT | MADLVYSLRHF | DRNDCDILKE | ILVLRGCC | TADYFDRKDWY | DFVENPDI | | | | | |
| <i>Hedgehog-CoV</i> | GKHYKTNTCRFV | ELDDQGHKLD | SFYVVKRHTM | ENYELERHCYD | LLKACDSVA | AHDFVFDVKTK | TPHIVRQRLTE | YTMMDLVYAL | RHFDQNNCEV | LKTIIVRYGC | CEESYFDNKL | WDFVENPD | | | | | |
| <i>MERS-CoV</i> | GKYYKTNTCRFV | ELDDQGHKLD | SFYVVKRHTM | ENYELKHCYD | LLRDCDAVA | PHDFIFDVKV | TKTPHIVRQRL | TEYTMMDLVY | ALRHFQNN | SEVLKAILV | KYGCCEQSY | FDNKLWF | DFVENPSV | | | | |
| <i>MHV</i> | GLYYKVNCCRFQ | RVEDDGNKLD | KFFVVKRNTLEV | YNKEKECYEL | TKECGVVAE | HDFTFDVEGSRV | PHIVRQSLTE | YTMMDLVYAL | RHFDQNN | SEVLKAILV | KYGCCEQSY | FDNKLWF | DFVENPDI | | | | |
| <i>OC43</i> | GLHLKVNCCRFQ | RVDENGDKLD | QFFVVKRTDLT | YNREMECYERV | KDKCFVAEHDF | TFDVEGSRVPHI | VRKDLTKYTML | DLCYALRHFDR | NDCMMLCDIL | SIYAGCEQSY | FTKKDWYDF | VENPDI | | | | | |
| <i>Rat-CoV</i> | GLYYKVNCCRFQ | RVEDDGNKLD | KFFVVKRNTLEV | YNKEKECYEL | TKECGVVAE | HDFTFDVEGSRV | PHIVRQSLTE | YTMMDLVYAL | RHFDQNN | SEVLKAILV | KYGCCEQSY | FDNKLWF | DFVENPDI | | | | |
| <i>SARS-CoV</i> | AKFLKTNCCRFQ | EKDEEGNLLD | SFYVVKRHTMS | NYOHEETIYN | LLKDCPAVA | KHDFKFRV | DGDMVPHISRQ | RLTKYTMADLV | YALRHFDE | GNCDTLKEI | LVTYNCCDD | YFNKKDWY | DFVENPDI | | | | |
| <i>229E</i> | GKNLKSNCVRFK | NVD----KDA | FYIVKRCIKS | VMDEHQSMYN | LLKGCNAVA | KHDFFWHEGR | TIYGNVSRQDL | TKYTMDL | CFALRN | FDEKDCGV | FEILVLTG | CCNTDY | FEMKNW | DFIENEDI | | | |
| <i>Bat-CoV-1A</i> | GKFKVNCVRFK | NLD----KDA | FAFIVKRC | TKSVMHEQ | SIYDILKY | SALAIHDF | FLWKDGRAI | YGNICRQDL | TKYTMDL | VNALRN | FDEKNCEV | LKEILITG | ACDSSY | FDNKS | WYDPVENEDI | | |
| <i>BtCoV512</i> | SKFLKVNCRVRL | KNLD----KDA | FAFIVKRC | TKSVMHEQ | SIYDILKY | SALAIHDF | FLWKDGRAI | YGNICRQDL | TKYTMDL | VNALRN | FDEKNCEV | LKEILITG | ACDSSY | FDNKS | WYDPVENEDI | | |
| <i>BtMr-AlphaCoV</i> | GKFLKVNCRVRF | RNAD----KDA | FAFIVKRC | TKSVMHEQ | SIYDILKY | SALAIHDF | FLWKDGRAI | YGNICRQDL | TKYTMDL | VNALRN | FDEKNCEV | LKEILITG | ACDSSY | FDNKS | WYDPVENEDI | | |
| <i>BtNv-AlphaCoV</i> | GKFLKVNCRVRF | RNVD----KDA | FAFIVKRC | TKSVMHEQ | SIYDILKY | SALAIHDF | FLWKDGRAI | YGNICRQDL | TKYTMDL | VNALRN | FDEKNCEV | LKEILITG | ACDSSY | FDNKS | WYDPVENEDI | | |
| <i>BtRf-AlphaCoV</i> | GKFLKVNCRVRF | KNPE----YND | AFFVIKCKP | KSVMHEQ | SIYDILK | DGAVASHDF | FWKDGRAI | YGNISRQNL | TKYTMDL | VYALRN | FDEKNC | ETLKEILV | LTGACE | ESYFESK | VWDFVENEDI | | |
| <i>CDPHE15</i> | GQFLKVNCRVRF | RNTD----MHA | FVIVKRC | TKSVMDEH | QSIYDKL | LAKDAVA | KHDFFWKEGR | SIYGNVCR | CNLTKYT | MDFALRN | FDERNC | QTLKEILV | LTGACD | ESYFENK | LWDFVENEDI | | |
| <i>FCoV</i> | GKFLKTNCSRFR | NLD----KHA | YVIVKRC | TKSVMDEH | QVCYNDL | KDSGVVAE | HDFLYKEGR | CEFGNARK | DLTKYT | MMDL | CYAIRNF | DEKNCEV | LKEILV | LTGACN | ESFFENK | DWDFVENE | |
| <i>Ferret-CoV</i> | GKFLKTNCSRFR | NLD----LHA | YVIVKRC | TKSVMDEH | QVCYNAL | KHSGAVASH | DFEYNEGR | SIFGNV | CRDLTKY | TMDL | CYALRN | FDEKNCEV | LKEILV | LTGCCD | SSYFDN | PNWYDPVENE | |
| <i>HKU10</i> | GKFLKTNCRVRF | RNKL----KHA | FVIVKRC | PKSVMHEQ | SIYDILK | DGSAIATH | DFVWKDGR | MIYGNISR | QDLTKY | TMDL | VYALRN | FDEKNC | ETLKEILV | ITGACD | QSYFDN | KWDFVENEDL | |
| <i>HKU2</i> | GKFLKVNCRVRL | KNLD----KHA | FAFIVKRC | TKSVMHEQ | SMYNKLS | GSNALAVH | DFFWKDG | RSIYGNV | CRQDL | SKYT | MMDL | CYALRN | FDERNC | ETLKEILV | LTGCCD | QSYFDN | KWYDPVENEDL |
| <i>HKU8</i> | GKFKVNCVRFK | NAD----KHA | FVIVKRC | TKSVMHEQ | SIYDAL | KDCGAVSPH | DFVWKDGR | SVYGNIA | RHDLTKY | TMDL | VHALRN | FDEKNC | ETLKEILV | ISGACD | SSYFDN | KWYDPVENEDI | |
| <i>LuchengRn-CoV</i> | TKFPKINCRVRF | RNTE----KHA | YVIVKCN | ARVMDEY | QSIYNKL | VHSNALAV | HDFFPYKEGR | SIFGNIT | RHDLTKY | TMDL | CFALRN | FDEKNC | DVLKEILV | LTNCCD | EKYFDN | PNWYDPVENE | |
| <i>Mink-CoV</i> | GKFLKTNCSRFR | NLD----AHD | YVIVKRC | TKSVMDEH | QVCYNAL | KHSNALASH | DFEYSEGR | HVGNV | CRRLTKY | TMDL | CYALRN | FDEKNC | DVLKEILV | LTNCCD | SFFDN | PNWYDPVENE | |
| <i>NL63</i> | GKCLKMNCVRF | KNAD----LKD | GFVIVKRC | TKSVMHEQ | SMYNLLN | FSGALAEH | DFFWKDG | RVYGNV | SRHNLTKY | TMDL | VYAMRN | FDEQNC | DVLKEILV | LTGCCD | NSYFDS | KGWYDPVENE | |
| <i>NL63-related</i> | GKCLKVNCRVRF | KNAE----LKD | GFVIVKRC | TKSVMHEQ | SMFNLLS | GSNALAQH | DFFWKDG | RVYGNV | SRQNLTKY | TMDL | VYAMRN | FDEQNC | DVLKEILV | LTGCCD | NSYFDN | KSWYDPVENE | |
| <i>Porcine-EDV</i> | GKFLKVNCRVRL | KNLD----KHA | FAFVIVKRC | TKSVMHEQ | SIYSRLEK | CGAIAEHDF | FWKDGRAI | YGNVCR | KDLTEY | TMDL | CYALRN | FDERNC | DVLKSI | LKVGAC | EEESYFN | KVWDFVENEDI | |
| <i>TGE</i> | GKFLKTNCSRFR | NLD----KHA | YVIVKRC | TKTVMDEH | QVCYNDL | KDSGVAE | HDFFTYKEGR | CEFGNARR | NLTKY | TMDL | CYAIRNF | DEKNCEV | LKEILV | TVGACT | EEFFENK | DWDFVENE | |



5850 5860 5870 5880 5890 5900 5910 5920 5930 5940 5950 5960

Bat-BCoV NVYARLGERIRCNLLKTVKFC DAMKRHGI VGVLTLDNQDLNGNWCDFGDFVVRGFPNGVVPVDSYSSLMLPLMTMTKMLEAETHVDCDL-TKDHWKVDLLQYDYTEHRLNLHQYFKYWDMPYHPNC

Bovine-CoV NVYKKGPIFNRLVSATEFADKLEVGLVGLITLDNQDLNGKWDYDFGDYVIAAPGCGVAIADSYSSYMPMLTMCCHALDCELYVN-----NAYRLFDLVQYDFTDYKLELFNKYFKHWSMPYHPNT

Covid-19 RYVANLGERVRQALLKTVQFC DAMRNAGI VGVLTLDNQDLNGNWDYDFGDFIQTPPGSGVVPVDSYSSLMLPILTLTRALTAESHVDTDL-TKPYIKWDLKLDYDFTTEERLKLFDRIYFKYWDQTYHPNC

GCCDC1 SVYHKLGETVRNAVLSANKMADAMV KAGLVGVLTLDNQDLNGKWDYDFGDFIEAPPGTGVAVMDTYSSLAMPVYTMNTMLAAECHVDGDL-TKPKRVVDLCVYDYTQFKYSLFQKYFKYWDQTYHPNC

HKU1 NIYKKGPIFNRLNLTVI FADTLVEVGLVGVLTLDNQDLNGKWDYDFGDFIQTPAGFGVAVADSYSSYMPMLTMCCHVLDCELFVN-----DSYRQFDLVQYDFTDYKLELFNKYFKYWGMYHPNT

HKU14 NVYKKGPIFNRLVNTAEFADALVEAGLVGVLTLDNQDLNGMWDYDFGDYVVTAPGCGVAVADSYSSYMPMLTMCCHALDCELYVN-----NTYRQFDLVQYDFTDYKLELFNKYFKHWSMPYHPNT

HKU24 NVYKKGPIFNRLNLTAKFADAMVEAGLVGVLTLDNQDLNGI WYDFGDFVLAAPGCGVAIADSYSSYMPMLTMCCHALDSELYVN-----GAYRQFDLVQYDFTDYKLELFNKYFKYWTMPYHPNT

HKU4 GVYHKLGERIRQAMLN TVKMDHMVKSGLVGVLTLDNQDLNGKWDYDFGDFVITQPGAGVAIVDSYSSYLMPVLSMTNCLAAETHKDCDF-NKPLIEWPLLEYDYTDYKIGLFNKYFKYWDQTYHPNC

HKU5 SVYHKLGERIRQAVLNTVKFC DQMVKSGLVGVLTLDNQDLNGKWDYDFGDFVITQPGAGVAIVDSYSSYLMPVLSMTNCLAAETHRDCDL-TKPLIEWPLLEYDYTDYKIGLFEKYFKYWDQTYHPNC

HKU9 RVYHNLGETVRKAVLSAVKMADSMVEQGLI GVLTLDNQDLNGQWYDFGDFIEGPAGAVAVMDTYSSLAMPVYTMNTMLAAECHVDGDL-TKPKRVVDLCVYDYTQFKYSLFQKYFKYWDQTYHPNC

Hedgehog-CoV RVYHKLGEVRRAMLSTVKFC DHMVKSGLVGVLTLDNQDLNGKWDYDFGDFVVTQPGAGVAIVDSYSSYLMPVLSMTDALAAETHKDCDL-SKPLIEWSLLDYDFTDYKLCLEFEKYFKHWDQTYHPNC

MERS-CoV GVYHKLGERVRQAILN TVKFC DHMVKAGLVGVLTLDNQDLNGKWDYDFGDFVITQPGSGVAIVDSYSSYLMPVLSMTDCLAAETHRDCDF-NKPLIEWPLTEYDFTDYKVLQFEKYFKYWDQTYHANC

MHV NVYKKGPIFNRLNLTAKFADALVEAGLVGVLTLDNQDLNGQWYDFGDFVKTVP GCGVAVADSYSSYMPMLTMCCHALDSELFVN-----GTYREFDLVQYDFTDFKLELFTKYFKHWSMTYHPNT

OC43 NVYKKGPIFNRLVSATEFADKLEVGLVGVLTLDNQDLNGKWDYDFGDYVIAAPGCGVAIADSYSSYIMPMLTMCCHALDCELYVN-----NAYRLFDLVQYDFTDYKLELFNKYFKHWSMPYHPNT

Rat-CoV NVYKKGPIFNRLNLTAKFADALVEAGLVGVLTLDNQDLNGQWYDFGDFVKTVP GCGVAVADSYSSYMPMLTMCCHALDSELYVN-----GTYREFDLVQYDFTDFKLELFTKYFKHWSMTYHPNT

SARS-CoV RYVANLGERVROSLKTVQFC DAMRDAGI VGVLTLDNQDLNGNWDYDFGDFVOVAPGCGVPIVDSYSSYLMLPILTLTRALTAESHMDADL-AKPLIKWDLKLDYDFTTEERLCLFDRIYFKYWDQTYHPNC

229E RVYAALGKVVANAMLKCVAFCD E MVLKGVVGVLTLDNQDLNGNFYDFGDFVLCPPGMGIPYCTSYAYMMPVMGMTNCLASECFMKSDFGQDFKTFDLLKYDFTTEHKEVLFNKYFKYWGQDYHPDC

Bat-CoV-1A RVYAKLGDVIANAMLKCVALCDAMTEKGI VGVITLDNQDLNGNFYDFGDFVTSIPGVGVVCTSYSSYMPAMPANCLARECFIKSDFGSDFKTFDLELYDFTTEHKLKLFDKYFKYWGQDYHPDC

BtCoV512 RVYAKLGTIVARAMLKCVKYCDAMVEQGI VGVITLDNQDLNGDFYDFGDFVTSVKGMPVICTSYSSYMPVMGMTNCLASECFIKSDFGEDFRFTDLLAYDFTTEHKVNLFNKYFKHWSGQTYHPNC

BtMr-AlphaCoV KVYAQLGVIIVANAMLKCVRLCDAMVEKGI VGVITLDNQDLNGDFYDFGDFCKTAPGMGVPCCTSYSSYMPVMGMTNCLASECFMKSDFGEDFKTYDLELYDFTTEHKERLFKKYFKYWDQDYHPNC

BtNv-AlphaCoV RVYAALGRIVNTAMLNCVKLCDAMVEKGI IGVLTLDNQDLNGLFYDFGDFSFTMPGMGVPCCTSYSSYMPVMGMTNCLASECFMKSDFGSDFKTFDLELYDFTTEHKSLLFEKYFKYWGQDYHPNC

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FCoV EVYARLGPVIANAMLKCVAFCD A IVEKGYIGIITLDNQDLNGNFYDFGDFVKTTPGFGCACVTSYSSYMPMLMGMTSCLSENFVKSDIYGADYKQYDLLAYDFTDHKEKLFHKYFKHWRDRTYHPNC

Ferret-CoV VVYAKLGRVVSANAMLKCVALCDAMVEKGLI GVLTLDNQDLNGNFYDFGDFVFTVEGYCACVTSYSSYMPIMGMTSCLSENFVKSDIYGSDYKQFDLLAYDFTAHKEMLFKYFKYWRDRTYHPNC

HKU10 RVYAILGKIVANAMLKCVRLGDAMVKHGI VGVITLDNQDLNGNFYDFGDFAKTLPGMGVPLCTSYSSYMPVMGMTNCLASECFIKSDFGSDFKSFDLLHYDFTDHKQALFEKYFKHWDQDYHPNC

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HKU8 RVYAKLGCVANAMLKCVALCDAMVAKGV VGVLTLDNQDLNGNFYDFGDFITIGIPGVVPLATSYSSYLMPVMGMTNCLARECFVKSEIFGSDFKTYDLELYDFTTEHKLGLFNKYFKHWDLDYHPNC

LuchengRn-CoV VVYKLGIVIANAMLKCVALCDAMVEKGLI GVLTLDNQDLNGNFYDFGDFVEGPEGYVPCVTSYSSYMPIMGMTNCLAQECYMNDSIFGKDFKRYDLLMYDFTTEHKEALFKKYFKYWDQVYHPNC

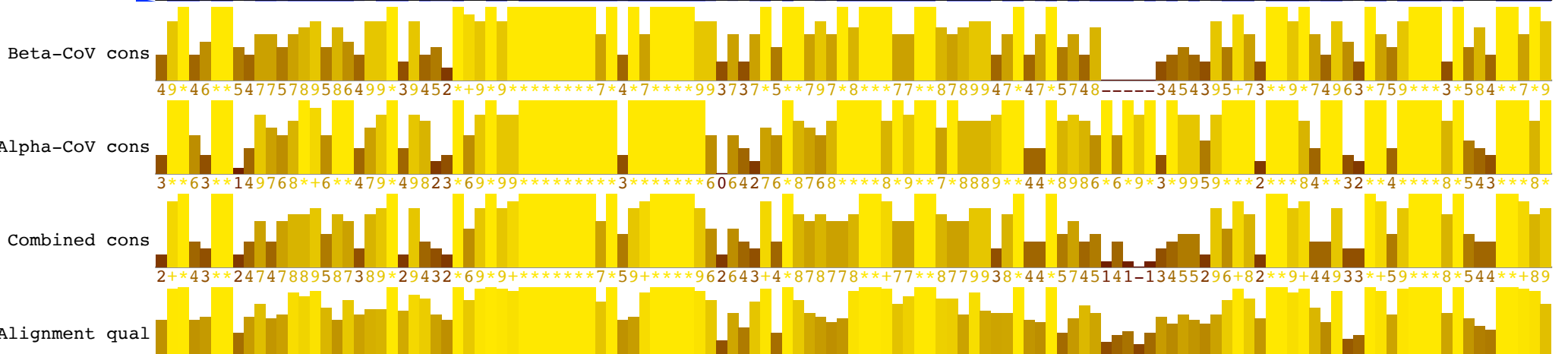
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NL63 RVYASLGKIVARAMLKCVALCDAMVAKGV VGVLTLDNQDLNGNFYDFGDFVVSPLPMGVPCCTSYSSYMPIMGLTCLASECFVKSDIFGSDFKTFDLLKYDFTTEHKNLNFNKYFKHWSFDYHPNC

NL63-related RVYAALGKVVANAMLKCVALCD E MVKGVVGVLTLDNQDLNGNFYDFGDFVVSPLPMGVPCCTSYSSYMPVMGLTCLASECFVKSDIFGSDFKTFDLLKYDFTTEHKNLNFNKYFKYWGFDYHPNC

Porcine-EDV RVYALLGTIVARAMLKCVKFC D AMVEQGI VGVVTLDNQDLNGDFYDFGDFTCSIKMGVPICTSYSSYMPVMGMTNCLASECFVKSDIFGEDFKSYDLELYDFTTEHKTALFNKYFKYWGQDYHPNC

TGE EVYAKLGPVIANAMLKCVAFCD A IVEKGYIGIITLDNQDLNGNFYDFGDFVKTAPGFGCACVTSYSSYMPMLMGMTSCLSENFVKSDIYGSDYKQYDLLAYDFTTEHKEYLFQKYFKYWRDRTYHPNC



5980 5990 6000 6010 6020 6030 6040 6050 6060 6070 6080 6090

Bat-BCoV QSCPDDRCILHCANFNVLSTTIPQTSFGPIVVKRIYVDGVPFVVSAGYHYKELGVVMNQDIHVHNAARLSIRELLVYAADPAMHAASGTLDDKRTTCFVSVAALNTNTVVFQTVKPGFNKDFYDFAVS

Bovine-CoV VDCQDDRCILHCANFNILFSMVLNPTCFGPLVRQIFVDGVPFVVSIGYHYKELGIVMNMVDVTHRYRLSLKDLLLYAADPALHVASASALYDLRTCCFVSAAITSGVKFQTVKPGFNQDFYDFILS

Covid-19 VNCLDDRCILHCANFNVLSTVFPPTSFGLPVRKIFVDGVPFVVSIGYHYKELGVVHNDVNLHSSRLSFKELLVYAADPAMHAASGNLLLDKRTTCFVSAALTNNVAFQTVKPGFNKDFYDFAVS

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Hedgehog-CoV VNCVDDRCILHCANFNVLFSMVLNPTCFGPLVRKVFVDGVPFVVSIGYHYKELGLVMNMDVNMHSHRSLKELMMYAADPAMHVASSNALLDLRTSCFVSAALATGLTFQTVRPGFNQDFYDFVVS

MERS-CoV VNCTDDRCVLHCANFNVLFSMVLNPTCFGLPVRKIFVDGVPFVVSIGYHYKELGLVMNMDVSLHRHRLSLKELMMYAADPAMHIASNAFLDLRTSCFVSAALTTGLTFQTVRPGFNQDFYDFVVS

MHV CECEDDRCILHCANFNILFSMVLNPTCFGPLVRQIFVDGVPFVVSIGYHYKELGVVMNMVDVTHRYRLSLKDLLLYAADPALHVASASALLDLRTCCFVSAAITSGVKFQTVKPGFNQDFYDFILS

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Rat-CoV CECEDDRCILHCANFNILFSMVLNPTCFGPLVRQIFVDGVPFVVSIGYHYKELGIVMNMVDVTHRYRLSLKDLLLYAADPALHVASASALYDLRTCCFVSAAITSGVKFQTVKPGFNQDFYDFILS

SARS-CoV VNCLDDRCILHCANFNVLSTVFPPTSFGLPVRKIFVDGVPFVVSIGYHYKELGVVHNDVNLHSSRLSFKELLVYAADPAMHAASGNLLLDKRTTCFVSAALTNNVAFQTVKPGFNKDFYDFAVS

229E VDCHDEMCIHCSNFNTLFAFATIPNTAFGLPVRKIFVDGVPVATAGYHFQKGLVWNKDVNTHSTRITITELLQFVTDPTLIVASSPALVDKRTVCFVSAALSTGLTSQTVKPGHFNKEFYDFLRS

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BtMr-AlphaCoV CDCYDDMCVVHCANFNTLFAFATIPNTAFGLPVRKIFVDGVPVATAGYHFQKGLVWNKDVNTHSTRITINELLRFVSDPALLVASSPALVDQRTVCFVSAALGTGVTQTLKPGHFNKEFYDFLRS

BtNv-AlphaCoV VDCHDMCVVHCANFNTLFAFATIPNTAFGLPVRKIFVDGVPVATAGYHFQKGLVWNKDVNTHSTRITINELLRFVSDPALLVASSPALVDQRTVCFVSAALGTGVTQTLKPGHFNKEFYDFLRS

BtRf-AlphaCoV VDCHDEMCIHVCANFNTLFAFATIPNTAFGLPVRKIFVDGVPVATAGYHFQKGLVWNKDVNTHSTRITINELLRFVSDPALLVASSPALVDQRTVCFVSAALGTGVTQTLKPGHFNKEFYDFLRS

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Ferret-CoV SECIDDAELLHCANFNTLFAFATIPNTAFGLPVRKIFVDGVPVATAGYHFQKGLVWNKDVNTHSTRITINELLRFVSDPALLVASSPALVDQRTVCFVSAALGTGVTQTLKPGHFNKEFYDFVVA

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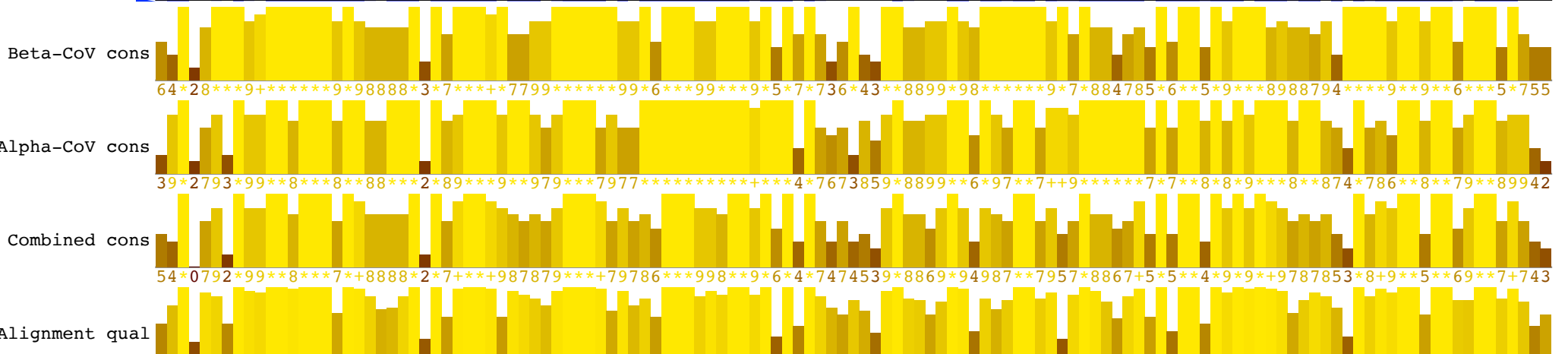
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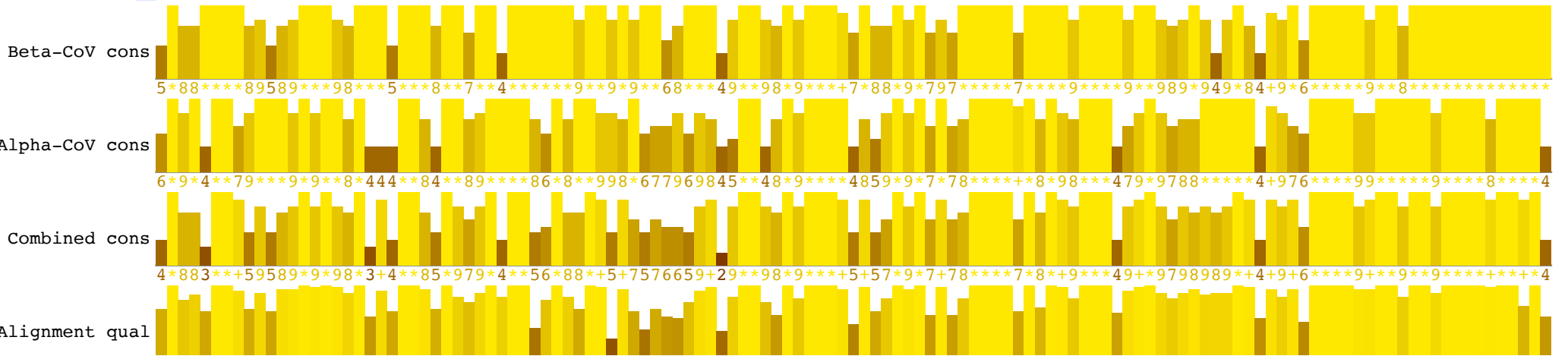
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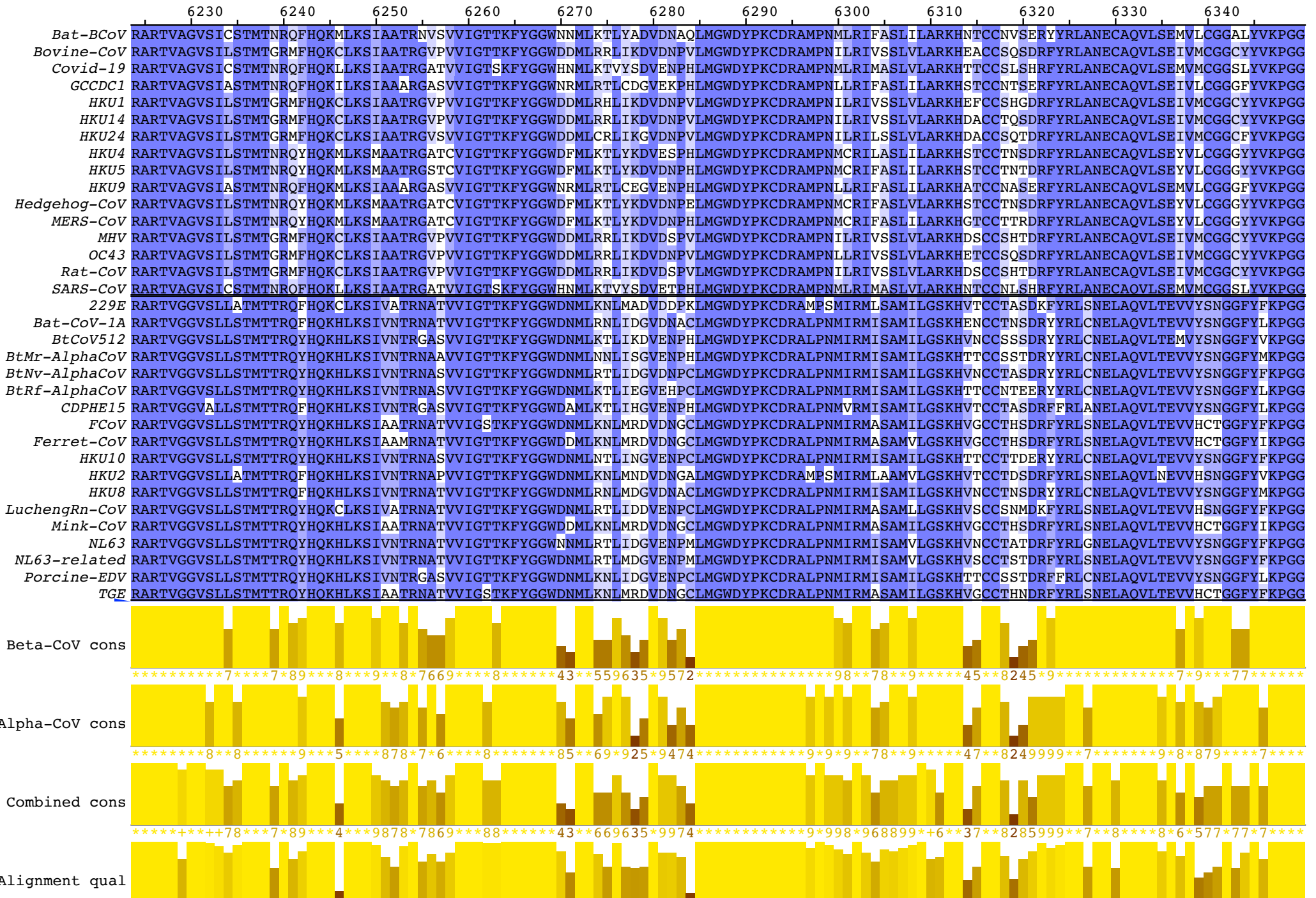
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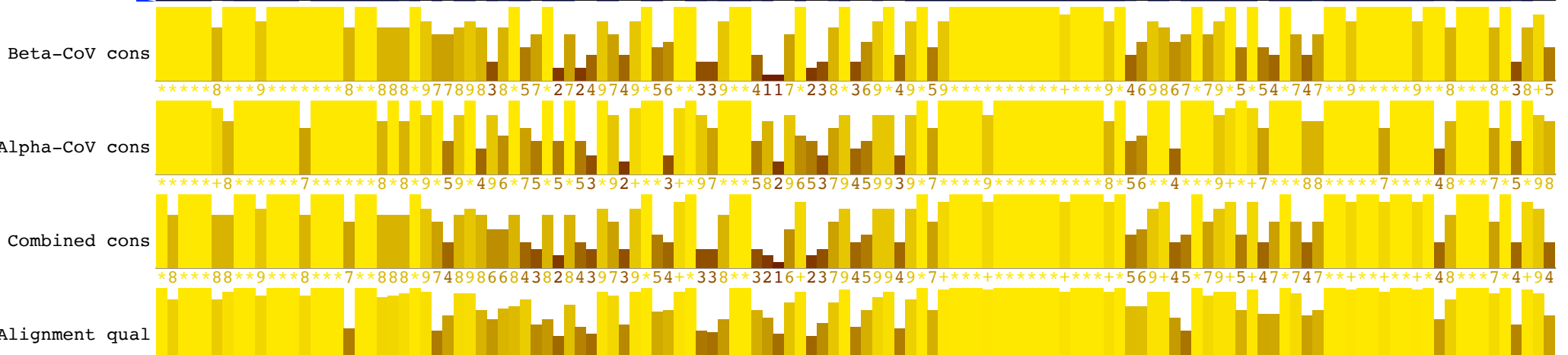


| | 6100 | 6110 | 6120 | 6130 | 6140 | 6150 | 6160 | 6170 | 6180 | 6190 | 6200 | 6210 | 6220 | | | | | | | | | | | |
|----------------------|------------|----------|----------|-----------|---------|----------|----------|-----------|-----------|---------|--------|--------|--------|---------|----------|----------|---------|---------|-------|-------|-------|-------|------|------|
| <i>Bat-BCoV</i> | KGFFKEGSSV | DLKHFFFA | QDGNAAIT | TDYSYYRYN | LPTMCDI | KQLLF | TMEVVDKY | FDCYDGG | CLNANQ | VVNSL | DKSAGF | PFNKWG | KARLYY | ESLSYED | QDALFAY | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | | |
| <i>Bovine-CoV</i> | KGLLKEGSSV | DLKHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYDGG | CIPASQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDEIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>Covid-19</i> | KGFFKEGSSV | ELKHFFFA | QDGNAAIS | DYDYYRY | NLPTM | CDIRQLL | FVLEVVDK | YFDCYDGG | CINANQ | VI | VNNL | DKSAGF | PFNKWG | KARLYY | DSMSYED | QDALFAY | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>GCCDC1</i> | CGFFKEGSS | ISFKHFF | YAQDGNAA | ISDYDYY | RYNLPT | MCDIKQLL | FVLEVVDK | YFDCYEGG | CLQASQ | VI | VANNY | DKSAGF | PFNKFG | KARLYE | ESLSYED | QDALFAY | TKRNVLP | TVT | QOMNL | KYAI | SAKN | | | |
| <i>HKU1</i> | KGLFKEGST | VDLKHFF | TQDGNAAI | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYDGG | CIPASQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QNEIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>HKU14</i> | KGLLKEGSSV | DLKHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYDGG | CIPASQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDDIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>HKU24</i> | KGLLKEGSSV | DLRHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYDGG | CIPASQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDDIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>HKU4</i> | RGFFKEGSSV | TLKHFFFA | QDGHAAIT | TDYSYYA | YNLPT | MVDIKQML | FCMEVVD | KYFDIYDGG | CLNASE | VI | VNNL | DKSAGH | PFNKFG | KARVY | ESMSYQE | QDELFAV | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>HKU5</i> | KGFFKEGSSV | TLRHFFFA | QDGHAAIT | TDYSYYA | YNLPT | MCDIKQML | FCMEVVD | KYFEIYDGG | CLNASE | VI | VNNL | DKSAGH | PFNKFG | KARVY | ESMSYQE | QDELFAV | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>HKU9</i> | CGFFKEGST | ISFKHFF | YAQDGNAA | ISDYDYY | RYNLPT | MCDIKQLL | FVLEVVDK | YFDCYDGG | CLQASQ | VI | VANNY | DKSAGF | PFNKFG | KARLYE | ESLSYAD | QDELFAV | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>Hedgehog-CoV</i> | KGFFKEGSSV | TLKHFFFA | QDGHAAIT | TDYNYYS | YNLPT | MCDIKQLL | FVLEVVKY | FEIYDGG | CLNASE | VI | VNNL | DKSAGY | PFNKFG | KARVY | ESMSYQE | QDELFAV | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>MERS-CoV</i> | KGFFKEGSSV | TLKHFFFA | QDGNAAIT | TDYNYYS | YNLPT | MCDIKQML | FCMEVVKY | FEIYDGG | CLNASE | VI | VNNL | DKSAGH | PFNKFG | KARVY | ESMSYQE | QDELFAV | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>MHV</i> | KGLLKEGSSV | DLKHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYEGG | CIPATQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDEIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>OC43</i> | KGLLKEGSSV | DLKHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYDGG | CIPASQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDEIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>Rat-CoV</i> | KGLFKEGSSV | DLKHFFFT | QDGNAAIT | TDYNYKY | NLPTM | VDIKQLL | FVLEVVKY | FEIYEGG | CIPATQ | VI | VNNYD | KSAGY | PFNKFG | KARLYE | EALSFEE | QDEIYAY | TKRNVLP | TLT | QOMNL | KYAI | SAKN | | | |
| <i>SARS-CoV</i> | KGFFKEGSSV | ELKHFFFA | QDGNAAIS | DYDYYRY | NLPTM | CDIRQLL | FVLEVVDK | YFDCYDGG | CINANQ | VI | VNNL | DKSAGF | PFNKWG | KARLYY | DSMSYED | QDALFAY | TKRNVLP | TI | QOMNL | KYAI | SAKN | | | |
| <i>229E</i> | QGFFDEGSEL | TLKHFFFT | QKGDAAI | KDFDYRY | RNRP | TILDIGQ | ARVAYQ | VAARYF | DCYEGG | CITSRE | VVTVN | LNKSAG | WPLNKF | GKAGLY | YESISYEE | QDAIFLL | TKRNI | LPTMT | QNLN | KYAI | SGKE | | | |
| <i>Bat-CoV-1A</i> | HGFFDEGSEL | TLKHFFFA | QKGDAAI | RDFDFYR | YNRP | TVL | LDICQAR | VAYHV | VKKYFE | IYEGG | CIAARD | VVTVN | LNKSAG | YPLNKF | GKAGLY | EALSYEE | QDALYAV | TKRNI | LPTMT | QNLN | KYAI | SGKE | | |
| <i>BtCoV512</i> | QGFFEESSEL | TLKHFFFA | QKGDAAV | RDFDYRY | RNRP | TVL | LDICQAR | VYQIV | QCYFG | MYEGG | CITAKE | VI | VNNLN | KSAGY | PFNKFG | KAGLYD | DSL | SYEEQ | DLYAY | TKRNI | IPTMT | QNLN | KYAI | SGKD |
| <i>BtMr-AlphaCoV</i> | QGFFSESEL | TLKHFFFA | QKDDAAV | KDFDFYR | YNRP | TMLD | ICQARV | TYKIV | SRYFDC | YEGG | CITAKE | VVTVN | LNKSAG | WPLNKF | GKAGLY | D | DSL | SYEEQ | DLYAV | TKRNI | LPTMT | QNLN | KYAI | SGKE |
| <i>BtNv-AlphaCoV</i> | QGFFEESDL | TLKHFFFA | QKGDAAI | KDFDFYR | YNRP | TMLD | ICQARV | TYQIV | KRYFDI | YEGG | CITARE | VVTVN | LNKSAG | YPLNKL | GKAGLY | EALSYEE | QDLYAV | TKRNV | MPTMT | QNLN | KYAI | SGKE | | |
| <i>BtRf-AlphaCoV</i> | QGFFEESSEL | TLKHFFFA | QKGDAAI | KDFDYRY | RNRP | TVL | LDICQAR | VYKLV | SRYFEI | YEGG | CITAKE | VVTVN | LNKSAG | YPLNKF | GKAGLY | D | DSL | SYEEQ | DLYAV | TKRNV | LPTMT | QNLN | KYAI | SGKE |
| <i>CDPHE15</i> | HGFFEESSEL | TLKHFFFA | QKGDAAV | KDFDFYR | YNK | TMLD | ICQARV | VYKLV | SRYFEI | YEGG | CITAKE | VVTVN | LNKSAG | WPLNKI | GKAGTY | EESLSYEE | QDEL | YAL | TKRNI | LPTMT | QNLN | KYAI | SGKE | |
| <i>FCoV</i> | RGFFEESSEL | TLKHFFFA | QGGAAIT | DFNYRY | RNRV | TVL | LDICQ | AQFVK | IVGKYF | ECYDGG | CINARE | VVTVN | YD | KSAGY | PLNKF | GKARLYE | ETLSYEE | QDALF | AL | TKRNV | LPTMT | QOMNL | KYAI | SGKA |
| <i>Ferret-CoV</i> | RGFFAEGCEL | TLKHFFFA | QGGAAIT | DFNYRY | RNKT | TVL | LDICQ | AQFV | QLVNKY | FECYDGG | CITARE | VVTVN | YD | KSAGY | PLNKF | GKARLYE | ETLSYEE | QDEL | FAT | TKRNV | LPTMT | QOMNL | KYAI | SGKA |
| <i>HKU10</i> | QGFFEESSEL | TLKHFFFA | QKGDAAI | KDFDYRY | RNKP | TMLD | VCQAR | VAYKLV | SRYFDI | YEGG | CITAKD | VVTVN | LNKSAG | YPLNKF | GKAGLY | ESLTYEE | QDALYAV | TKRNV | LPTMT | QNLN | KYAI | SGKE | | |
| <i>HKU2</i> | QGFFDEGSEL | TLKHFFFA | QKGDAAV | ADDFYRY | RNKP | TMLD | ICMAR | FYVQ | RYFECYDGG | CITARE | VVTVN | LD | KSAGY | PLNRF | GKARLF | YETFSYEE | QDALYAM | TKRNI | LPTMT | QNLN | KYAI | SGKA | | |
| <i>HKU8</i> | QGFFDEGSEL | TLKHFFFA | QKGDAAI | RDFDFYR | YNRP | TVL | LDICQAR | VAYHV | VKRYFDI | YEGG | CIAARD | VVTVN | LNKSAG | YPLNKF | GKASLY | EESLSYEE | QDALYAL | TKRNV | LPTMT | QNLN | KYAI | SGKE | | |
| <i>LuchengRn-CoV</i> | RGFFNEGSDL | TLRHFFFA | QNGAAIT | DFDYRY | RNHT | TMLD | ICQAR | VFKV | VGKYFECY | EGG | CIMAKD | VI | TVNLD | KSAGY | PLNKF | GKARLYE | ESMTYEE | QDALYAM | TKRNV | LPTMT | QNLN | KYAI | SGKA | |
| <i>Mink-CoV</i> | RGYFAEGSDL | TLKHFFFA | QSGAAIT | DFNYRY | RNRP | TVL | LDICQ | AELV | QIVAKY | FDCYDGG | CITARE | VVTVN | YD | KSAGY | PLNKF | GKARLYE | ETLSYEE | QDEL | FAT | TKRNV | LPTMT | QOMNL | KYAI | SGKA |
| <i>NL63</i> | RGFFDEGSEL | TLKHFFFA | QNGDAAV | KDFDFYR | YNKPT | ILDIC | QARV | TYKIV | SRYFDI | YEGG | IKACE | VVTVN | LNKSAG | WPLNKF | GKASLY | EESLSYEE | QDALF | AL | TKRNV | LPTMT | QNLN | KYAI | SGKE | |
| <i>NL63-related</i> | KGFFDEGSEL | TLKHFFFA | QKGDAAV | KDFDFYR | YNRP | TMLD | ICQAK | VTYKIV | SRYFDI | YEGG | CITARE | VVTVN | LNKSAG | WPLNKF | GKAGLY | EESLSYEE | QDALFAM | TKRNI | LPTMT | QNLN | KYAI | SGKD | | |
| <i>Porcine-EDV</i> | QGFFSESEL | TLKHFFFA | QKVDAAV | KDFDYRY | RNRP | TVL | LDICQAR | VYQIV | QRYFDI | YEGG | CITAKE | VVTVN | LNKSAG | YPLNKF | GKAGLY | EESLSYEE | QDEL | YAY | TKRNI | LPTMT | QNLN | KYAI | SGKE | |
| <i>TGE</i> | RGFFEESSEL | TLKHFFFA | QGGAAIT | DFNYRY | RNRV | TVL | LDICQ | AQFVK | IVGKYF | ECYDGG | CINARE | VVTVN | YD | KSAGY | PLNKF | GKARLYE | ETLSYEE | QDALF | AL | TKRNV | LPTMT | QOMNL | KYAI | SGKA |

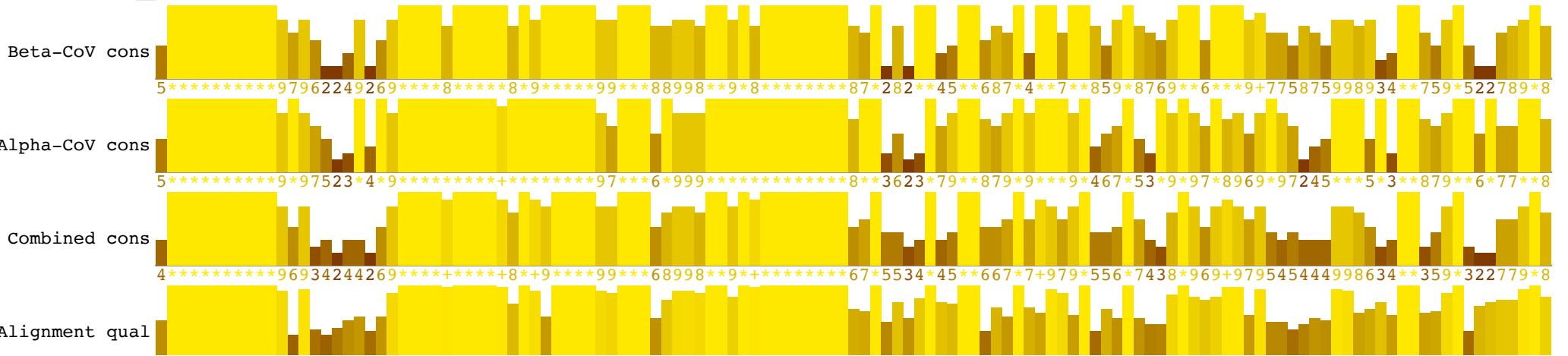




| | 6360 | 6370 | 6380 | 6390 | 6400 | 6410 | 6420 | 6430 | 6440 | 6450 | 6460 | 6470 |
|----------------------|--|------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | TSSGDATTAYANSVFNICQAVTANISALLAANGNKIVDVIIRDLRKLYANVYRSVHVYKFFVDEYYAFLRKHFSSMMILSDDGVVVCYNSDYVARGYIAGIKDFKQVLYYQNNVFMSEAKCWVPEPDLT | | | | | | | | | | | |
| <i>Bovine-CoV</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGNKIEDLSIRALQKRLYSHVYRSDMVDSTFVTEYEFNLKHFSSMMILSDDGVVVCYNSDYASKGYIANISAFQOVLYYQNNVFMSESKCWVENDIN | | | | | | | | | | | |
| <i>Covid-19</i> | TSSGDATTAYANSVFNICQAVTANVALLSTDGNKIADKYVRNLQHRLEYCLYRNRDVTDFVNEFYAYLRKHFSMMILSDDAVVCNFTYASQGLVASIKNFKSVLYYQNNVFMSEAKCWTEPDLT | | | | | | | | | | | |
| <i>GCCDC1</i> | TSSGDSSTAYANSVFNICQAVSANLNTFLSRDGNKIYNSYVQGLQRRLYLGIYRTHVTDMELVTEYFYAYLRKHFSMMILSDDGVVVCYNSDYASKGYIADIQGFKELLYYQNNVFMSEAKCWVPEPDLT | | | | | | | | | | | |
| <i>HKU1</i> | TSSGDATTAFANSVFNICQAVTANVCSLMACNGHKIEDLSIRNLQKRLYSNVYRTDYVDYTFVNEYEFNLCKHFSSMMILSDDGVVVCYNSDYASKGYIANISVFFQOVLYYQNNVFMSESKCWVENDIT | | | | | | | | | | | |
| <i>HKU14</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGNKIEDLSIRALQKRLYSHVYRSDTVDPSTFVTEYEFNLKHFSSMMILSDDGVVVCYNSDYASKGYIANISAFQOVLYYQNNVFMSEAKCWVENDIN | | | | | | | | | | | |
| <i>HKU24</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGNKIEDLSIRSLQKRLYSHVYRSDYVDPAFVNEFYEFNLKHFSSMMILSDDGVVVCYNSDYASKGYIANISAFQOVLYYQNNVFMSESKCWVENDIK | | | | | | | | | | | |
| <i>HKU4</i> | TSSGDATTAYANSVFNILQATTANVSALMSANGNTIIDREIKDMQFDLYINVYRKVVPDPKFFVDKYAFLNRKHFSMMILSDDGVVVCYNSDYAAKGYVASTIQNFKETLYYQNNVFMSEAKCWVETNLE | | | | | | | | | | | |
| <i>HKU5</i> | TSSGDATTAYANSVFNILQATTANVSALMGANGNTIVDEEVKDMQFELYVNVYRKSQDPKFFVDKYAFLNRKHFSMMILSDDGVVVCYNSDYATKGYIASTIQNFKETLYYQNNVFMSEAKCWVETDLK | | | | | | | | | | | |
| <i>HKU9</i> | TSSGDSSTAYANSVFNICQAVSANLNTFLSIDGNKIYTYVQELQRRLYLGIYRNTVDNELVLDYNYLRKHFSMMILSDDGVVVCYNSDYAASKGYIADIQGFKELLYYQNNVFMSESKCWVPEPDLT | | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | TSSGDATTAYANSVFNILQAVTSNVSALMSANGNKIIDKEVKDMQFELYVNVYRNSKDPKFFVDKYAFLNRKHFSMMILSDDGVVVCYNSDYAARGYIAGIQNFKETLYYQNNVFLSEAKCWVPEPDLT | | | | | | | | | | | |
| <i>MERS-CoV</i> | TSSGDATTAYANSVFNILQATTANVSALMGANGNKIIDKEVKDMQFDLYVNVYRSTSPDPKFFVDKYAFLNRKHFSMMILSDDGVVVCYNSDYAASKGYIAGIQNFKETLYYQNNVFMSEAKCWVETDLK | | | | | | | | | | | |
| <i>MHV</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGHKIEDLSIRELQKRLYSNVYRADHVPDFVSEYEFNLKHFSSMMILSDDGVVVCYNSDYEFASKGYIANISAFQOVLYYQNNVFMSEAKCWVETDIE | | | | | | | | | | | |
| <i>OC43</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGNKIEDLSIRALQKRLYSHVYRSDKVDSTFVTEYEFNLKHFSSMMILSDDGVVVCYNSDYASKGYIANISAFQOVLYYQNNVFMSESKCWVEHDIN | | | | | | | | | | | |
| <i>Rat-CoV</i> | TSSGDATTAFANSVFNICQAVSANVCALMSCNGNKIEDLSIRALQKRLYSHVYRADHVPDFVSEYEFNLKHFSSMMILSDDGVVVCYNSDYEFASKGYIANISAFQOVLYYQNNVFMSEAKCWVETDIE | | | | | | | | | | | |
| <i>SARS-CoV</i> | TSSGDATTAYANSVFNICQAVTANVALLSTDGNKIADKYVRNLQHRLEYCLYRNRDVTDFVNEFYAYLRKHFSMMILSDDAVVCNFTYASQGLVASIKNFKAVLYYQNNVFMSEAKCWTEPDLT | | | | | | | | | | | |
| <i>229E</i> | TSSGDATTAYANSVFNIFQAVSSNINCVLSVNSSNCFNVKQLQRLYDNCYRNSNVDESFDVDFYGYLQKHFSSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNVFMSTAKCWTEEDLS | | | | | | | | | | | |
| <i>Bat-CoV-1A</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>BtCoV512</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>CDPHE15</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>FCoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>Ferret-CoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGVNSNTCNLTVKELQKRLYDNCYRSTVDPDFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>HKU10</i> | TSSGDATTAYANSVFNIFQAVSSNINRLLTIDSNVSNVSVKTLQRELYDNCYRSSVDEQFIDKYCYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>HKU2</i> | TSSGDATTAYANSVFNIFQAVSSNINRLLTIDSNVSNVSVKTLQRELYDNCYRSSVDEQFIDKYCYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLS | | | | | | | | | | | |
| <i>HKU8</i> | TSSGDATTAYANSVFNIFQAVSANINRILGINSNTCNLAVKSLQRLYDNCYRSSVDPGFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGINSNTCNLAVKSLQRLYDNCYRSSVDPGFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>Mink-CoV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGINSNTCNLAVKSLQRLYDNCYRSSVDPGFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>NL63</i> | TSSGDATTAYANSVFNIFQAVSSNINRLLTIDSNVSNVSVKTLQRELYDNCYRSSVDEQFIDKYCYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>NL63-related</i> | TSSGDATTAYANSVFNIFQAVSSNINRLLTIDSNVSNVSVKTLQRELYDNCYRSSVDEQFIDKYCYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>Porcine-EDV</i> | TSSGDATTAYANSVFNIFQAVSANINRILGINSNTCNLAVKSLQRLYDNCYRSSVDPGFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |
| <i>TGE</i> | TSSGDATTAYANSVFNIFQAVSANINRILGINSNTCNLAVKSLQRLYDNCYRSSVDPGFVDFYGYLRKHFSMMILSDDGVVVCYNSDYAELGYIADISAFKATLYYQNNVFMSTAKCWVEEDLT | | | | | | | | | | | |



| | 6480 | 6490 | 6500 | 6510 | 6520 | 6530 | 6540 | 6550 | 6560 | 6570 | 6580 | 6590 | 6600 |
|----------------------|---|------|------|------|------|------|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | KGPHEFCSQHTMLVEHNGEQVYLPYPDPSRILGACCFVDDVVKTDGTMIERFVALAIDAYPLTKHENPEYKQVFFYLLQYIKKLHEELTGHLLDMYSVMSISGDNAQRYWEEDFYEAMYTQSVTLQA | | | | | | | | | | | | |
| <i>Bovine-CoV</i> | NGPHEFCSQHTMLVKMDGDDVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVYHENEYQKQVFRVYLEYIKKLYNDLGNQILDSYSVILSTCDGQKFTDES FYKNMYLRSAVMQS | | | | | | | | | | | | |
| <i>Covid-19</i> | KGPHEFCSQHTMLVKQGDYVYLPYPDPSRILGAGCFVDDIVKTDGTLMIERFVSLAIDAYPLTKHPNQEYADVFLHYLQYIRKLDHDEL TGHMLDMYSVMLTNDNTRSRYWEPEFYEAMYTPHTVLA | | | | | | | | | | | | |
| <i>GCCDC1</i> | KGPHEFCSQHTMLVDMHGEQVYLPYPDPSRILGAGCFVDDLKTDGTLMIERFVSLAIDAYPLTKHDAEYQNVFVCYLYQYIKKLHEELTGHLLDTYSVMLASDNASKYWEVEFYENMYTFSATLQS | | | | | | | | | | | | |
| <i>HKU1</i> | NGPHEFCSQHTMLVKIDGYVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVHHENEYQKQVFRVYLEYIKKLYNDLGTQILDSYSVILSTCDGKFTDES FYKNMYLKSAVMQS | | | | | | | | | | | | |
| <i>HKU14</i> | HGPHEFCSQHTMLVKMDGDDVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVYHENEYQKQVFRVYLEYIKKLYNDLGNQILDSYSVILSTCDGQKFTDES FYKNMYLRSAVMQS | | | | | | | | | | | | |
| <i>HKU24</i> | NGPHEFCSQHTMLVKMDGDDVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVYHENEYQKQVFRVYLEYIKKLYNDLGNQILDSYSVILSTCDGQKFTDES FYKNMYLRSAVMQS | | | | | | | | | | | | |
| <i>HKU4</i> | KGPHEFCSQHTLYIKDGDGYFLPYDPSRILSAGCFVDDIVKTDGTMVERFVSLAIDAYPLTKHDDTEYQNVFVYLYQYIEKLYKDLTGHMLDSYSVMLCGDSSAKFWEEGFYRDLYSSPTTLQA | | | | | | | | | | | | |
| <i>HKU5</i> | KGPHEFCSQHTLFIKGDGDGYFLPYDPSRILSAGCFVDDIVKTDGTLMIERFVSLAIDAYPLTKHDDPEYQNVFVYLYQYIEKLYKDLTGHMLDSYSVMLCGDSSAKFWEESFYRDLYTAPTTLQA | | | | | | | | | | | | |
| <i>HKU9</i> | KGPHEFCSQHTMLVDMKGEQVYLPYPDPSRILGAGCFVDDLKTDGTLMIERFVSLAIDAYPLTKHPDPEYQNVFVCYLYQYIKKLHEELTGHLLDTYSVMLASDNASKYWEVEFYENMYTFSATLQS | | | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | KGPHEFCSQHTLLIKEGEDHYFLPYDPSRILSAGCFVDDI IKTDGTLMIERFVSLAIDAYPLTKHDNIEYQNVFVYLYQYIEKLYKDLTGHMLDTYSVMLCGDNSSKFWEQFYKDLYSAPTTLQA | | | | | | | | | | | | |
| <i>MERS-CoV</i> | KGPHEFCSQHTLYIKDGDGYFLPYDPSRILSAGCFVDDIVKTDGTLMIERFVSLAIDAYPLTKHEDIEYQNVFVYLYQYIEKLYKDLTGHMLDSYSVMLCGDSSAKFWEAFYRDLYSSPTTLQA | | | | | | | | | | | | |
| <i>MHV</i> | KGPHEFCSQHTMLVKMDGDEVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVYHENPEYQNVFVYLYQYIEKLYKDLTGHMLDSYSVILSTCDGQKFTDES FYKNMYLRSAVLQS | | | | | | | | | | | | |
| <i>OC43</i> | NGPHEFCSQHTMLVKMDGDDVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVYHENEYQKQVFRVYLAYIKKLYNDLGNQILDSYSVILSTCDGQKFTDES FYKNMYLRSAVMQS | | | | | | | | | | | | |
| <i>Rat-CoV</i> | KGPHEFCSQHTMLVKMDGDEVYLPYPDPSRILGAGCFVDDLKTDVLLIERFVSLAIDAYPLVHHENEYQKQVFRVYLEYIKKLYNDLGNQILDSYSVILSTCDGQKFTDES FYKNMYLRSAVMQS | | | | | | | | | | | | |
| <i>SARS-CoV</i> | KGPHEFCSQHTMLVKQGDYVYLPYPDPSRILGAGCFVDDIVKTDGTLMIERFVSLAIDAYPLTKHPNQEYADVFLHYLQYIRKLDHDEL TGHMLDMYSVMLTNDNTRSRYWEPEFYEAMYTPHTVLA | | | | | | | | | | | | |
| <i>229E</i> | IGPHEFCSQHTMQIVDEKGYLYLPYPDPSRIISAGVFVDDVTKTDAVILLERYVSLAIDAYPLSKHPKPEYRKFVYALLDQVWVHLNKTNLNEGVLSEFSVTLLDEHESKFWDESFYASMYEKSTVLQA | | | | | | | | | | | | |
| <i>Bat-CoV-1A</i> | KGPHEFCSQHTLQIVDGDGTYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>BtCoV512</i> | KGPHEFCSQHTMQIVDKDGTYYLPLYPDPSRILSAGVFVDDIVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | KGPHEFCSQHTMQIVDENGKYYLPLYPDPSRILSAGVFVDDIVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | KGPHEFCSQHTMQIVDENGKYYLPLYPDPSRILSAGVFVDDIVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | KGPHEFCSQHTMQIVDEAGKYYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLTKHNSPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>CDPHE15</i> | KGPHEFCSQHTMQITDKDGSYFLPYDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>FCoV</i> | VGPHEFCSQHTLQIVDGDGTYLPLYPDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLTKHPKPAYQKVFYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>Ferret-CoV</i> | VGPHEFCSQHTMQITTPDGDYLLPYDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLTKHPKPAYQKVFYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>HKU10</i> | KGPHEFCSQHTMQIVDENGKYYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>HKU2</i> | VGPHEFCSQHTMQIVSDGDYLLPYDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>HKU8</i> | KGPHEFCSQHTMQIVDGDGTYLPLYPDPSRILSAGVFVDDIVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>LuchengRn-CoV</i> | VGPHEFCSQHTLQIVDGDGTYLPLYPDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>Mink-CoV</i> | VGPHEFCSQHTMQIVTPDGDYLLPYDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLTKHPKPAYQKVFYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>NL63</i> | KGPHEFCSQHTMQIVDKDGTYYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>NL63-related</i> | KGPHEFCSQHTMQIVDKDGTYYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>Porcine-EDV</i> | KGPHEFCSQHTMQIVDKDGTYYLPLYPDPSRILSAGVFVDDVVKTDVILLERYVSLAIDAYPLSKHPNPEYRKFVYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |
| <i>TGE</i> | VGPHEFCSQHTLQIVDGDGTYLPLYPDPSRILSAGVFVDDIVKTDVIMLERYVSLAIDAYPLTKHPKPAYQKVFYVLLDQVWVHLNNTLNNEGVLSEFSVTLLDSSSKFWEDEGFYASLYEKSSVLA | | | | | | | | | | | | |



6610 6620 6630 6640 6650 6660 6670 6680 6690 6700 6710 6720 67:

Bat-BCoV VGACVLCNSQTSLRGDCIRRPFLCCKCCYDHVLS^TPHKLVLSVSPYVCNAPGCEVTDV^TQLYLGGMSYFC^KSKHKPPI^SFPPLCANGQVFLYKNTCVGSIN^VADFN^AIATCDWSSSGDYVLAN^TTTE

Bovine-CoV VGACVVCSSQTSLRGSCIRKPLLCCKCCYDHVMA^TDHKYVLSVSPYVCNAPGCDVNDV^TTKLYLGGMSY^CEDHKPQ^YSFKLV^MNGMV^FFLYKQ^SCTGSPY^IDDFN^RIASCKW^TDVDDY^ILANE^CTE

Covid-19 VGACVLCNSQTSLRGACIRRPFLCCKCCYDHV^ISTHKLVL^SVN^PYVCNAPGCDV^TDV^TQLYLGGMSY^CCKSHK^PPI^SFPPLCANGQVFLYKNTCVGS^DNV^TDFN^AIATCDW^TNAGDY^ILANE^CTE

GCCDC1 VGTCTVVCSSQTSLRGACIRRPFLCCKCCYDHV^ISTHKLVL^SVN^PYVCNAPGCDV^TDV^TQLYLGGMSY^CCKSHK^PPI^SFPPLCANGQVFLYKNTCVGS^DNV^TDFN^AIATCDW^TNAGDY^ILANE^CTE

HKU1 VGACVVCSSQTSLRGSCIRKPLLCCKCCYDHVMA^TNHKYVLSVSPYVCNAPN^CDVSDV^TTKLYLGGMSY^CENH^KPH^YSFKLV^MNGMV^FFLYKQ^SCTGSPY^IDDFN^KIASC^KWTEVDDY^VLANE^CIE

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229E AGLCVVCGSQTVLRCGDCLRRPMLCTKAYDHV^FGTDR^HFILAI^TTPYVCN^TSGCNV^TDV^TTKLYLGG^LNYYC^VDHK^PHL^SFPPLCSAGNVFLYKSSAL^GSM^DIDVFN^KLSTSDW^SDIRDY^KLANDA^KE

Bat-CoV-1A SGLCVVCGSQTVLRCGDCLRRPMLCTKAYDHV^ISTH^KFIL^SI^TPYMCN^TSGCTVNDV^TTKLYLGG^LSY^CIDHK^PTLA^FPLCSNG^NI^FFLYK^NSATGSPDVE^VFN^TLATSE^WNDAK^DYRLANE^VKD

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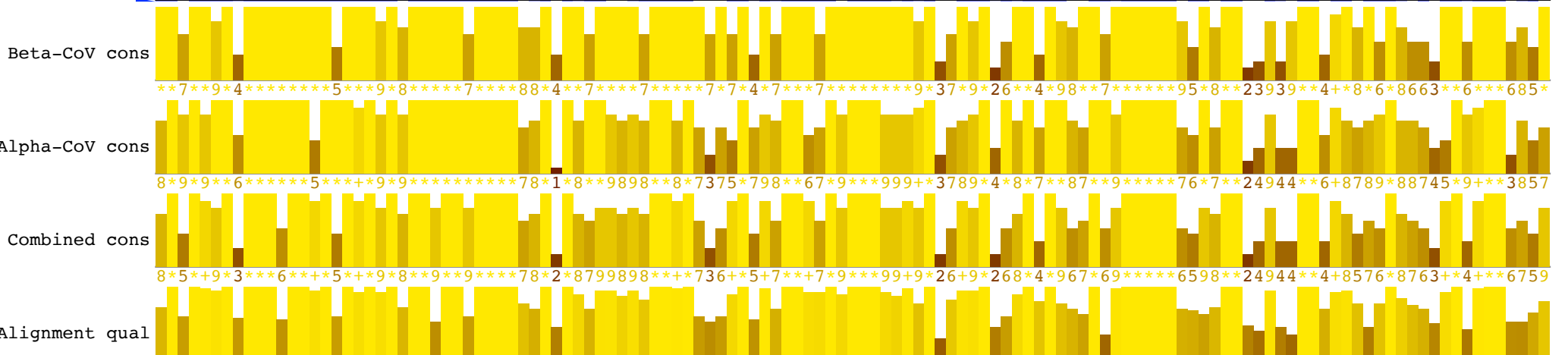
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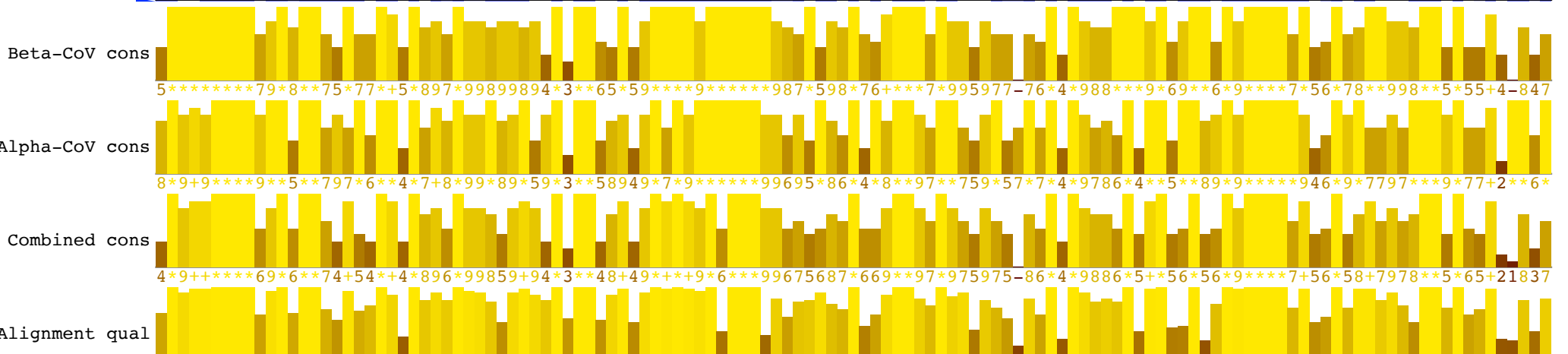
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Porcine-EDV AGLCVVCGSQTVLRCGDCLRRPMLCTKAYDHV^IGTTH^KFILAI^TTPYVCSASDCG^VNDV^TTKLFLG^LSY^CWEHK^PRLA^FPLCSAGNVFLYKNSATGSPDVE^VFN^RIATSDW^TDV^SYRLAN^DVKD

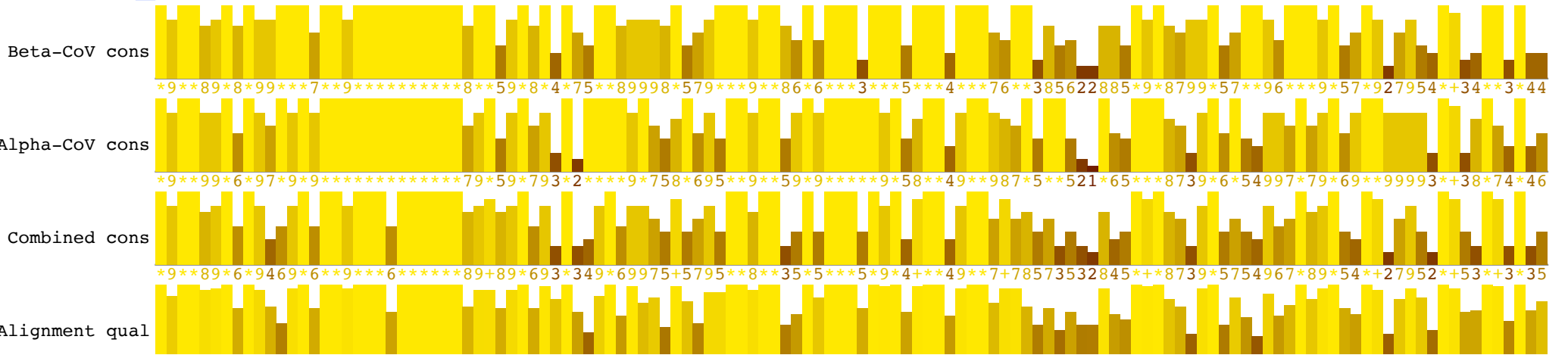
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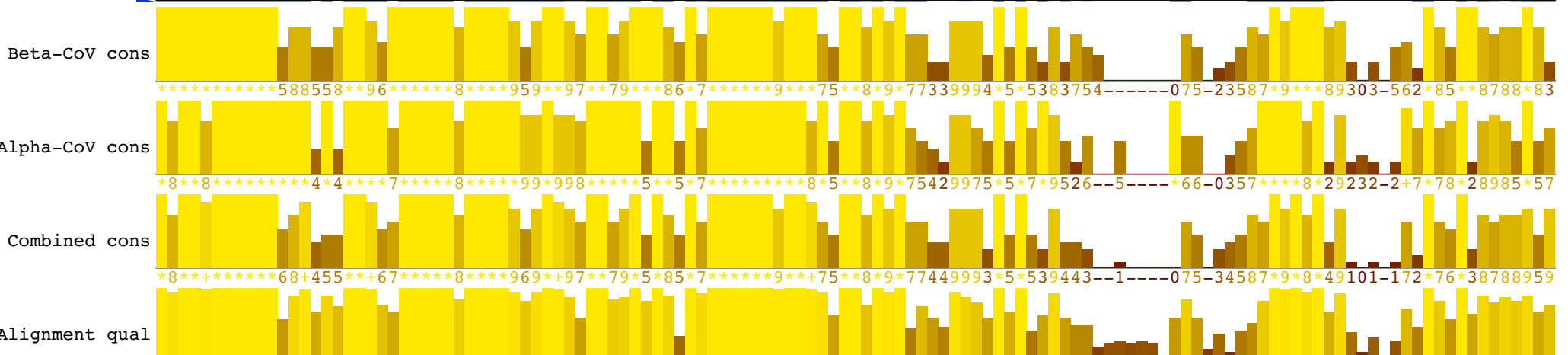
| | 6740 | 6750 | 6760 | 6770 | 6780 | 6790 | 6800 | 6810 | 6820 | 6830 | 6840 | 6850 | | | | | |
|----------------------|------------|-----------|------------|-----------|----------|------------|-----------|-----------|----------|----------|----------|----------|----------|-----------|-----------|----------------------|------------------|
| <i>Bat-BCoV</i> | RLKLFAAETL | KAVEETAKQ | SYGVAVVRE | VVSDKVEIL | RWEADKPR | PLNRNYVFT | GYRITKNSK | TQIGEYTFE | KSDYGD | DSVLYKAS | TTYKLQV | GDYFVLT | SHSVLPLS | APTLLPQET | YTRIVGLYP | | |
| <i>Bovine-CoV</i> | RLKLFAAET | QKATEEAF | KQSYASATI | QIEIVSERE | LILSWEIG | KVKPPLNK | NYVFTGYH | FTKNGKTV | LGEYVFD | KSELTNG | VYRATTTY | KLSVGDV | FVLTSHS | VANLSAPT | LVPQENYSS | IR-FAS | |
| <i>Covid-19</i> | RLKLFAAET | LKATEEET | FKLSYGIAT | VREVLSDRE | LHLSWEV | GKPRPLNR | NYVFTGYR | VTKNSKVQ | IGEYTFE | KGDYGD | DAVYRGT | TTYKLVN | VDYFVLT | SHTVMPLS | APTLLPQEH | YVRIETGLYP | |
| <i>GCCDC1</i> | RLKLFAAET | LRATEENAK | QAYASATV | KEVLSEREL | VLSEVVGK | TRPLNRNY | VFTGFHIT | KNKSVQIG | EYIFEK | GDYGD | DVVYRAS | TTYRLQV | GDYFVLT | SHSVQALS | SSPTLLPQ | ERYTKLVGLYP | |
| <i>HKU1</i> | RLKLFAAET | QKATEEAF | KQSYASATI | QIEIVSDRE | VILCWETG | KVKPPLNK | NYVFTGYH | FTSTGKTV | LGEYVFD | KSELTNG | VYRATTTY | KLSIGDV | FVLTSHS | VASLSAPT | LVPQENYAS | IR-FSS | |
| <i>HKU14</i> | RLKLFAAET | QKATEEAF | KQSYASATI | QIEIVSDRE | LILSWETG | KVKPPLNK | NYVFTGYH | FTKNGKTV | LGEYIFD | KSELTNG | VYRATTTY | KLSVGDV | FVLTSHS | VANLSAPT | LVPQENYSS | IR-FAS | |
| <i>HKU24</i> | RLKLFAAET | QKATEEAF | KQSYASATI | QIEIVSDRE | LILSWEV | GKVRPPLN | KNYVFTG | YHFTKNGK | TVLGEYV | FDKSELT | NGVYRAT | TTYKLSV | GDVFLV | LTSHTV | MSAPLTP | QEHYTSIK-FPS | |
| <i>HKU4</i> | PLKLFAAET | LRATEEAS | KQSYAIATI | KEIVGEREL | LIVVEV | GKSKPPLNR | NYVFTGYH | LTKNSKVQ | LGEYVFE | RIDYS | DAVYKSS | TTYKLAV | GDI | FVLTSHS | VATLSAPT | IVNQERYLKITGIYP | |
| <i>HKU5</i> | PLKLFAAET | LRATEEAS | KQSYAIATI | KEIVGEREL | LIVWEAG | KAKPPLNR | NYVFTGYH | ITKNSKVQ | LGEYVFE | RIDYS | DAVYKSS | TTYKLAV | GDI | FVLTSHS | VATLSAPT | IVNQERYVKITGLYP | |
| <i>HKU9</i> | RLKLFAAET | LRATEENAK | QAYASAVV | KEVLSEREL | VLSEVVGK | TRPLNRNY | VFTGFHIT | KNKSVQIG | EYIFEK | GDYGD | DVVYRAS | TTYRLQV | GDYFVLT | SHSVQALS | SSPTLLPQ | ERYTKLVGLYP | |
| <i>Hedgehog-CoV</i> | PLKLFAAET | LRATEEAS | KQSYAIATI | KEIVGEREL | LIVWEAG | KSKPPLNR | NYVFTGYH | ITKNSKVQ | LGEYVFE | RVDYS | ETVYKSS | TTYKLSIG | DIFVLT | SHSVATL | TAPTIVN | QEKYVKITVGLYP | |
| <i>MERS-CoV</i> | PLKLFAAET | LRATEEAS | KQSYAIATI | KEIVGERE | QLLIVWE | AGSKPPLNR | NYVFTGYH | ITKNSKVQ | LGEYIFE | RIDYS | DAVYKSS | TTYKLVG | DIFVLT | SHSVATL | TAPTIVN | QERYVKITGLYP | |
| <i>MHV</i> | RLKLFAAET | QKATEEAF | KQCYASATI | REIVSDRE | LILSWEIG | KVRPPLNK | NYVFTGYH | FTNNGKTV | LGEYVFD | KSELTNG | VYRATTTY | KLSVGDV | FVLTSH | HAVSSLS | APTLLPQEN | YTSIR-FAS | |
| <i>OC43</i> | RLKLFAAET | QKATEEAF | KQSYASATI | QIEIVSERE | LILSWEIG | KVKPPLNK | NYVFTGYH | FTKNGKTV | LGEYVFD | KSELTNG | VYRATTTY | KLSVGDV | FVLTSHS | VANLSAPT | LVPQENYSS | IR-FAS | |
| <i>Rat-CoV</i> | RLKLFAAET | QKATEEAF | KQCYASATI | REIVSDRE | LILSWEIG | KVRPPLNK | NYVFTGYH | FTNNGKTV | LGEYVFD | KSELTNG | VYRATTTY | KLSVGDV | FVLTSHS | HAVSSLS | APTLLPQEN | YTSIR-FAS | |
| <i>SARS-CoV</i> | RLKLFAAET | LKATEEET | FKLSYGIAT | VREVLSDRE | LHLSWEV | GKPRPLNR | NYVFTGYR | VTKNSKVQ | IGEYTFE | KGDYGD | DAVYRGT | TTYKLVN | VDYFVLT | SHTVMPLS | APTLLPQEH | YVRIETGLYP | |
| <i>229E</i> | SLRLFAAET | VKAKEESV | KSSYAYATL | KEIVGPKEL | LLWESGK | AKPPLNRNS | VFTCFQIT | KDSKQV | GEFVFE | KVDYGS | DTVTYK | STATTKL | VPGMLF | ILTSHNV | APLRAPT | MANQEKYSTIYKLRP | |
| <i>Bat-CoV-1a</i> | SLRLFAAET | VKAREESV | KSSYAAATL | KEVIGPRE | SLLSWEV | GKVPPLNR | NSVFTCYQ | ITKDSK | QVGEYTFE | KLDYDN | DTVSYR | SSTTYKL | APGMIF | VLTSHNV | PPLRAP | TIANQERYASYIKLRP | |
| <i>BtCoV512</i> | SLRLFAAET | IKAKEESV | KSSYACATL | HEVVGPK | ELVLKWE | VGKPRPPL | SRNSVFTCY | HITKNTK | FQVGEFT | FEKLDY | DNDAV | SYKSTAT | TKLVPG | MVFLTSH | NVQPLRAP | TIIINQERYSTLHKLRP | |
| <i>BtMr-AlphaCoV</i> | SLRLFAAET | VKAREESV | KQYASATL | KEIIGPKEL | LLSWEV | GKVPPLNR | NSVFTCFQ | ISKDSK | YQVGEFT | FEKADY | SDTVIY | KSTSTSK | LCPGML | FVLTSHN | VAPLRAP | TIANQERYSSIFKLRP | |
| <i>BtNv-AlphaCoV</i> | SLRLFAAET | VKAKEECIK | KSSYACATL | REIIGPKEL | LLSWEV | GKPRPPLNR | NSVFTGFQ | ITKDSK | MLGEFT | FEKLDY | SDAVYK | STTKL | SPGVL | FVLTSHN | VAPLRAP | TIANQEKYSTIVKLRP | |
| <i>BtRf-AlphaCoV</i> | SLRLFAAET | VKAKEESV | KSSYACATL | KEVIGPKEL | LLSWEV | GKVPPLNR | NSVFTCFQ | ITKDSK | FQVGEFT | FEKLDY | GSDAV | CYKSTAT | NKLVPG | MIFVLT | SHNVQPL | RAPTIANQERYSSIYKLYP | |
| <i>CDPHE15</i> | SLRLFAAET | IKASEENIK | SSYACATIRE | VIGPKEL | LISWEAG | KTPALNRNS | VFTGFHIT | KNMKSQ | IGEFTE | FKSDYD | SDAVIY | KSTTTV | KLQPGM | FVLTSHN | VQSLRAP | TIANQERYANLVKLRP | |
| <i>FCoV</i> | SLKIFAAET | VKAKEESV | KSEYAYAIL | KEVIGPKE | IVLQWE | ASKTKPPLNR | NSVFTCFQ | ISKDTKI | QLGEFV | FEQSEY | GSVYYK | STSTYKL | TPGMIF | VLTSHNV | SPLKATIL | VNQEKYNTISKLYP | |
| <i>Ferret-CoV</i> | SLKLYAAET | IKATEESV | KQYACAVL | KEIVGPK | EVVLQWE | ASKIKPPLNR | NSVFTCYQ | ILKDSKI | QLGEFV | FEQSEY | GSVYYK | STSTTKL | VPGMLF | FVLTSHN | VGSLKAP | VLLNQEKYSTISKLYP | |
| <i>HKU10</i> | SLRLFAAET | IKAKEESV | KSSYACATL | KEVIGPKEL | LLSWEV | GKVPPLNR | NSVFTCFH | ITKDSK | FQVGEF | VFEKVD | YGSDAV | SYKSTST | SKLSPG | MVFLTSH | NVQPLRAP | TIANQERYSSIHKLYP | |
| <i>HKU2</i> | SLRLFAAET | IKAREESV | KSSYACATL | KEIIGPKEL | LLQWEV | GKARPPLNR | NSVFTCFQ | ISKDSK | WQVGEFT | FEKLDY | GSDTV | CYKSNV | TAKLVPG | MIFVLT | SHNVLS | LKAPTIANQERYSTIYKLYP | |
| <i>HKU8</i> | SLRLFAAET | VKAKEECV | TSSYAAATL | KEIIGPKEL | LLSWEV | GKIKPPLNR | NSVFTCFQ | ITKDSK | FQVGEFT | FEKLDY | GSDTV | CYKSTAT | CKLQPG | MIFVLT | SHNIQPL | RAPTIANQERYAAICKLRP | |
| <i>LuchengRn-CoV</i> | SLKLFAAET | VKAKEESV | KSSYAIATL | KEIVGNRE | IVLQWE | ASKTKPPLNR | NSVFTGY | YINKDA | KFQMG | EYTFE | KSDYGN | DSVFYK | ANTTTKL | IPGMIF | VLTSHNV | APLRAP | IVNQERYTSICKLYP |
| <i>Mink-CoV</i> | SLKLFAAET | IKATEESV | KQYACAVL | KEVVGPK | EVVLQWE | ASKTKPPLNR | NSVFTCYQ | ILKDSK | VQLGEF | VFEQTE | YGGDAV | YKSTST | TKLVPG | MIFVLT | SHNVGAL | KAPVLVNQEKYSTISKLYP | |
| <i>NL63</i> | TLRLFAAET | IKAKEESV | KSSYAFATL | KEVVGPKEL | LLSWEV | GKVPPLNR | NSVFTCFQ | ISKDSK | FQIGEF | IFEKVE | YGS | DTVTYK | STVTTKL | VPGMIF | VLTSHNV | QPLRAP | TIANQEKYSSIYKLRP |
| <i>NL63-related</i> | SLRLFAAET | IKAKEESV | KSSYAFATL | KEVVGPKEL | LLSWEV | GKVPPLNR | NSVFTCFQ | ISKDSK | FQIGEF | IFEKVD | YGS | DTVTYK | STATTKL | VPGMIF | ILTSHNV | QPLRAP | TIANQERYSNYKLRP |
| <i>Porcine-EDV</i> | SLRLFAAET | IKAKEESV | KSSYACATL | HEVVGPKEL | LLKWEV | GRPKPPLNR | NSVFTCYH | ITKNTK | FQIGEF | VFEKA | EYDN | AVTYKTT | ATTKLV | PGMVFL | TSHNVQPL | RAPTIANQERYSTIHKLRP | |
| <i>TGE</i> | SLKIFAAET | VKAKEESV | KSEYAYAVL | KEVIGPKE | IVLQWE | ASKTKPPLNR | NSVFTCFQ | ISKDTKI | QLGEFV | FEQSEY | GSVYYK | STSTYKL | TPGMIF | VLTSHNV | SPLKAP | ILVNOEKYNTISKLYP | |



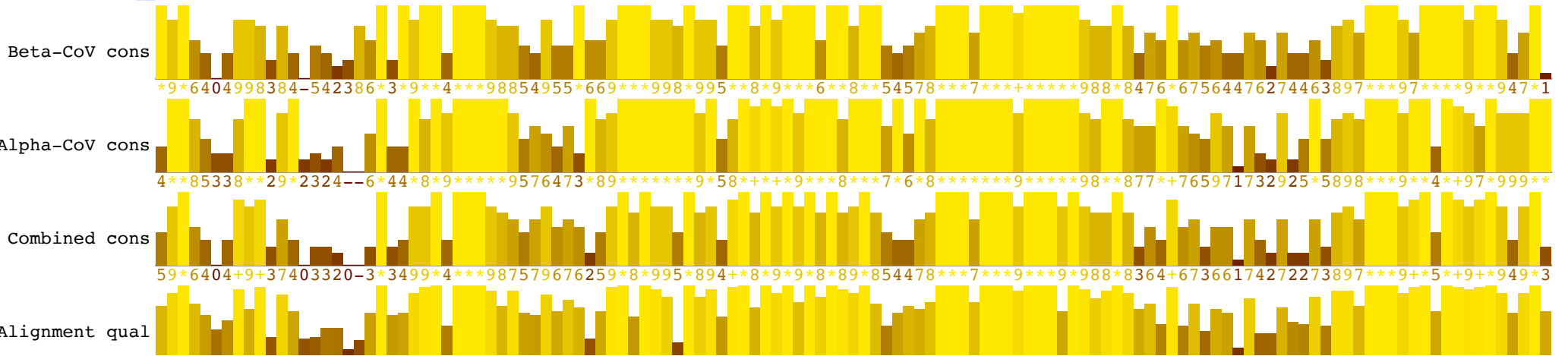
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|----------------------|-------|---------------|---------------|-------------|-----------|----------|---------|--------|-------|--------|--------|-------|---------|
| <i>Bat-BCoV</i> | YDLSI | INARVRAKHIVYV | GDPAQLPAPRTLL | TRGSL | LEPENFNSV | CRLMKT | LGPDIFL | GVCRRC | PKETV | DTVSEL | VYENK | LKAHK | PESSG |
| <i>Bovine-CoV</i> | YELSV | INARIRAKHYVY | IGDPAQLPAPRV | LLSKGT | LEPKYFNT | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNES |
| <i>Covid-19</i> | YDLSV | VNARLR | AKHYVYIGD | PAQLPAPRT | LLTKGT | LEPEYFNS | VCRIM | VAVGPD | IFLAT | CYRCP | KEIVD | TVSAL | VYDNK |
| <i>GCCDC1</i> | YDLSM | INARVRAKHIVYV | GDPAQLPAPRTLL | TGTLA | PEHFNSV | CRLMKT | IGPDM | FLGTC | RCRCP | PAEIV | DTV | SALVY | DNK |
| <i>HKU1</i> | YELSV | INARIRAKHYVY | IGDPAQLPAPRV | LLSKGS | LEPRHFNS | ITKIM | CCLGPD | IFLGN | CYRCP | KEIV | TVSAL | VYDNK | LKAKNDN |
| <i>HKU14</i> | YELSV | INARIRAKHYVY | IGDPAQLPAPRV | LLSKGS | LEPKYFNT | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNEN |
| <i>HKU24</i> | YELSV | INARVRAKHIVYV | IGDPAQLPAPRV | LLSKGT | LEPKYFNT | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNDK |
| <i>HKU4</i> | YDLSI | INSRV | KAKHYVY | GDPAQLPAPRT | LLIRG | TLEPEN | FNSVTR | LMCNL | GPDIF | LSVCY | RCPKEI | VSTV | SALVY |
| <i>HKU5</i> | YDLSV | INARIRAKHYVY | GDPAQLPAPRT | LLTRG | TLEPEN | FNSVTR | LMCNL | GPDIF | LSVCY | RCPKEI | VNTV | SALVY | DNK |
| <i>HKU9</i> | YDLSM | INARVRAKHIVYV | GDPAQLPAPRTLL | TGTLA | PEHFNSV | CRLMKT | IGPDM | FLGTC | RCRCP | PAEIV | DTV | SALVY | DNK |
| <i>Hedgehog-CoV</i> | YDLSI | INARVRAKHIVYV | GDPAQLPAPRTLL | TRGTL | EPENFNS | VTRFM | MCNL | GPDIF | LSTCY | RCPKEI | VTTV | SALVY | DNK |
| <i>MERS-CoV</i> | YDLSI | INARIRAKHYVY | GDPAQLPAPRTLL | TRGTL | EPENFNS | VTRFM | MCNL | GPDIF | LSTCY | RCPKEI | VTTV | SALVY | DNK |
| <i>MHV</i> | YELSV | INSRVRAKHIVYV | IGDPAQLPAPRV | LLNKG | TLEPRYFNS | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNDN |
| <i>OC43</i> | YELSV | INARIRAKHYVY | IGDPAQLPAPRV | LLSKGT | LEPKYFNT | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNES |
| <i>Rat-CoV</i> | YELSV | INSRVRAKHIVYV | IGDPAQLPAPRV | LLNKG | TLEPRYFNS | VTKLM | CCLGPD | IFLGT | CYRCP | KEIVD | TVSAL | VYDNK | LKAKNDN |
| <i>SARS-CoV</i> | YDLSV | VNARLR | AKHYVYIGD | PAQLPAPRT | LLTKGT | LEPEYFNS | VCRIM | VAVGPD | IFLAT | CYRCP | KEIVD | TVSAL | VYDNK |
| <i>229E</i> | YDLSV | INQRISYKHIVYV | GDQPQLPAPRV | LISK | GVMEF | IDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>Bat-CoV-1A</i> | YDLSV | INQRVSYRHIVYV | GDQPQLPAPRT | MITR | GVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>BtCoV512</i> | YDLSV | INQRVNYRHIVYV | GDQPQLPAPRV | MITR | GVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>BtMr-AlphaCoV</i> | YDLSI | INSRISYRHIVYV | GDQPQLPAPRT | MITK | GVLEPA | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>BtNv-AlphaCoV</i> | YDLSL | NQRVSYRHIVYV | GDQPQLPAPRT | MITK | GVLEPR | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>BtRf-AlphaCoV</i> | YDLSV | INQRVSYKHIVYV | GDQPQLPAPRT | MITR | GVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>CDPHE15</i> | YELSI | INQRVSYKHIVYV | GDQPQLPAPR | IMITR | GVLEPS | DYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>FCoV</i> | YDLSV | INSRISYKHIVYV | GDQPQLPAPRT | LIN | KGVLQ | PDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>Ferret-CoV</i> | YELSV | INSRVSYKHIVYV | GDQPQLPAPRT | LIN | KGVLK | PDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>HKU10</i> | YDLSV | INQRVSYKHIVYV | GDQPQLPAPRT | MITL | RGVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>HKU2</i> | YDLSI | VNARVAYKHIVYV | GDQPQLPAPRT | MITR | GVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>HKU8</i> | YDLSI | VNQRVAYKHIVYV | GDQPQLPAPRT | MITR | GVLEPK | DYNN | VVTQ | RMCAV | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>LuchengRn-CoV</i> | YDLSV | LN | SRVAYRHIVYV | GDQPQLPAPRT | LIT | KGAL | EPADY | NNVT | RLM | CTIG | PDV | FLN | KCYRCP |
| <i>Mink-CoV</i> | YELSV | INSRVSYKHIVYV | GDQPQLPAPRT | LIN | KGVLK | PDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>NL63</i> | YDLSV | INQRVSYKHIVYV | GDQPQLPAPRV | MITK | GVMEF | VDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>NL63-related</i> | YDLSV | INQRVSYRHIVYV | GDQPQLPAPRV | MIS | RGTLE | PKDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>Porcine-EDV</i> | YDLSV | INQRISYRHIVYV | GDQPQLPAPRV | MIS | RGTLE | PKDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |
| <i>TGE</i> | YDLSV | INSRISYKHIVYV | GDQPQLPAPRT | LIN | KGVLQ | PDYNN | VVTQ | RMCAI | IGPDV | FLH | KCYRCP | AEIV | NTV |



| | 7120 | 7130 | 7140 | 7150 | 7160 | 7170 | 7180 | 7190 | 7200 | 7210 | 7220 | 7230 |
|----------------------|-----------------------------|------------------------|-----------------------|--|--|------|------|------|------|------|------|------|
| <i>Bat-BCoV</i> | AVFISPYNSQNAVASKILGLQTQTVDS | QGSEYDYVIFAQTTDTAHS | CNVNRFNVAITRAKKGILC | IMSDPDMFERLKFVELAVPSRSQIR-LQA-TEITGLFKDCSKLIT-GLSPAMAPT | YMAVDD | | | | | | | |
| <i>Bovine-CoV</i> | AVFISPYNSQNF | AAKRVLGLQTQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGILC | VSMNQLFEALQFTTLTLDKVPQAVETRV-QCSTNLFKDCSKSYS-GYHPAHAPSFLAVDD | | | | | | | |
| <i>Covid-19</i> | AVFISPYNSQNAVASKILGLPTQTVDS | QGSEYDYVIFTOTTETAH | SNCNVNRFNVAITRAKKGILC | IMSDRDLYDKLQFTSL | EIPRRNVAT-LQA-ENVTGLFKDCSKVIT-GLHPTQAPTHLSVDT | | | | | | | |
| <i>GCCDC1</i> | AVFISPYNSQNAVARMLGLQTQTVDS | QGSEFDYVIYCSQSDTAHAL | NANRFNVAITRAKKGILC | VMSDSTLYDALDFVPM | DVTPQFIKPK-LQA-AAAVGLFKDCSKS-E-QVGPAYAPTFVSVND | | | | | | | |
| <i>HKU1</i> | AVFISPYNSQNYVAKRVLGVQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGIF | CVSMNQLFESLNFITLPLDKIQNTL | PRL-HCTTNLFKDCSKSCL-GYHPAHAPSFLAVDD | | | | | | | |
| <i>HKU14</i> | AVFISPYNSQNF | AAKRVLGLQTQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGILC | VCMNQLFEALQFTALTLDKVPV---KL-QCTTNLFKDCSKSYI-GYHPAHAPSFLAVDE | | | | | | | |
| <i>HKU24</i> | AVFISPYNSQNF | AAKRILGLQTQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGIF | CVSMNQLFEALDFMPLTLDKIPS---KL-QCVTNLFKDCSKSYV-GYHPAHAPSFVAVDE | | | | | | | |
| <i>HKU4</i> | AVFISPYNSQNAVARSLGLTTQTVDS | QGSEYPYVIFCQTADTAHANN | LNRFNVAITRAQK | GILCVMTSQVLFDSLEFAELSLNN---YK-LQS-QIVTGLFKDCSREDT-GLPPAYAPTYLSVDA | | | | | | | | |
| <i>HKU5</i> | AVFISPYNSQNAVARSLGLTTQTVDS | QGSEYPYVIFCQTADTAHANN | LNRFNVAITRAQK | GILCVMTSQALFDSLEFAEVLNN---YK-LQS-QIVTGLFKDCSRESS-GLHPAYAPTYVSVDD | | | | | | | | |
| <i>HKU9</i> | AVFISPYNSQNSVARMLGLQTQTVDS | QGSEFDYVIYCSQSDTAHAL | NVNRFNVAITRAKKGILC | VMSDSTLYESLEFTPLDVNDYV | KPK-MQS-EVTVGLFKDCAKA-E-PLGPAYAPTFVSVND | | | | | | | |
| <i>Hedgehog-CoV</i> | AVFISPYNSQNAVARSLGLNTQTVDS | QGSEYPYVIFCQTADTAHANN | LNRFNVAITRAQK | GILCVMTSQALFDSLQFSELSVNN---YK-LQS-QIVTGLYKDCSREMS-GLSPAYAPTYMSVDE | | | | | | | | |
| <i>MERS-CoV</i> | AVFISPYNSQNAVSRSLGLTTQTVDS | QGSEYQYVIFCQTADTAHANN | LNRFNVAITRAQK | GILCVMTSQALFESLEFTELSFTN---YK-LQS-QIVTGLFKDCSRETS-GLSPAYAPTYVSVDD | | | | | | | | |
| <i>MHV</i> | AVFISPYNSQNYVAKRVLGLQTQTVDS | AQGSEYDFVIYSQTAETAH | SVNVRFNVAITRAKKGILC | VSMNQLFESLNFITLTDKINN---PRL-QCTTNLFKDCSRSYV-GYHPAHAPSFLAVDD | | | | | | | | |
| <i>OC43</i> | AVFISPYNSQNF | AAKRVLGLQTQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGILC | VSMNQLFEALQFTTLTLDKVPQAVETKV-QCSTNLFKDCSKSYS-GYHPAHAPSFLAVDD | | | | | | | |
| <i>Rat-CoV</i> | AVFISPYNSQNYVAKRVLGLQTQTVDS | AQGSEYDYVIYSQTAETAH | SVNVRFNVAITRAKKGILC | VSMNQLFESLNFITLTDKINN---PRL-QCTTNLFKDCSKSYD-GYHPAHAPSFLAVDD | | | | | | | | |
| <i>SARS-CoV</i> | AVFISPYNSQNAVASKILGLPTQTVDS | QGSEYDYVIFTOTTETAH | SNCNVNRFNVAITRAKKGILC | IMSDRDLYDKLQFTSL | EIPRRNVAT-LQA-ENVTGLFKDCSKLIT-GLHPTQAPTHLSVDI | | | | | | | |
| <i>229E</i> | AVFISPYNSQNYVAARLLGLQTQTVDS | AQGSEYDYVIFAQTTDTAHS | CNVNRFNVAITRAKKGIF | CIMSDRTLFDALKFFVMTMT---D-----LQS-ESSCGLFKDCARNPI-DLPPSHATTYLSLSD | | | | | | | | |
| <i>Bat-CoV-1A</i> | AVFITPYNSQNYVASRVLGLQIQTVDS | QGSEYDYVIYTTQSDTAHACN | LNRFNVAITRAKKGIF | CVMDKALYDSLKFFEIQLT---D-----LQS-GDLCGLFKDCSRVEE-PLPPAYAPTYVSLSD | | | | | | | | |
| <i>BtCoV512</i> | AVFISPYNSQNYVAGRVLGLQIQTVDS | QGSEYDYVIYTTQSDTAHASN | VNRFNVAITRAKKGILC | IMCDRELFDIKFFYELKLS---D-----LQV-GDGCGLFKDCYKGED-NLPPSHAPTFMSLSD | | | | | | | | |
| <i>BtMr-AlphaCoV</i> | AVFISPYNSQNYVAARVLGLQIQTVDS | QGSEYDYVIYTTQSDTLHACN | VNRFNVAITRAKKGIF | CVMDRTLSDYDSLKFFEVKLS---D-----LQA-DNGCGLFKNCIRNEV-ILSPAYAPTYMALSD | | | | | | | | |
| <i>BtNv-AlphaCoV</i> | AVFISPYNSQNYVASRVLGLQIQTVDS | QGSEYDYVIYTTQSDTLHACN | LNRFNVAITRAKKGILC | VMDRSLFDALKFFYELKMT---D-----LQS-SDGCGLFKDCSRGSD-NLPPSHAPTYMSLSD | | | | | | | | |
| <i>BtRf-AlphaCoV</i> | AVFISPYNSQNYVASRALGLQIQTVDS | QGSEYDYVIYTTQSDTAHACN | VNRFNVAITRAKKGILC | VMCGKELFDALKFFEIKLT---D-----LQV-GECCGLFKDCSRKPD-LLPPSHATTFMSLSD | | | | | | | | |
| <i>CDPHE15</i> | AVFISPYNSQNYVASRSLGLQIQTVDS | QGSEYDYVIFTQSDTAHASN | VNRFNVAITRAKKGILC | VMCDKNLYDLLKFFYELKLS---D-----LQAQTDGCGLFKDCSRRDD-MLPPSHASTYMALSD | | | | | | | | |
| <i>FCoV</i> | AVFISPYNSQNYVARLLGLQTQTVDS | AQGSEYDYVIYTTQSDTQHATN | VNRFNVAITRAKVGILC | IMCDRTMYENLDFYELKDSKIG---D-----LQAKPETCGLFKDCSKSEQ-YIPPAYATTYMSLSD | | | | | | | | |
| <i>Ferret-CoV</i> | ATFISPYNSQNYVARLLGLQTQTVDS | AQGSEYDYVIYAQTSDTAHAVN | LNRFNVAITRAKVGILC | VMCDKPMYDGLNFIYITDV---N-----LQSKGEGCGLFKDCSKAER-YIPPAYATTYISLSD | | | | | | | | |
| <i>HKU10</i> | AVFISPYNSQNYVASRALGLQIQTVDS | QGSEYDYVIFTQSDTQHACN | VNRFNVAITRAKKGILC | IMCDKELFDALKFFEIKLT---D-----LQA-GECCGLFKDCSRKPD-LLPPSHATTFMSLSD | | | | | | | | |
| <i>HKU2</i> | AVFISPYNSQNYVAGRMLGLQTQTVDS | AQGSEYDYVIYTTQSDTSHALN | VNRFNVAITRTKIGILC | IMCDKALYDTLFFESIQS---D-----LQSTIGGCGLFKDCYKFDQ-DLPPAHATTYMALSD | | | | | | | | |
| <i>HKU8</i> | AVFISPYNSQNYVASRSLGLQIQTVDS | QGSEYDYVIFAQTSDTAHACN | LNRFNVAITRAKKGIF | CMCDKLLYEALKFFEVKLT---D-----LQA-GDTCGLFKDCSKFDDPPLPPSHAPTYVALSD | | | | | | | | |
| <i>LuchengRn-CoV</i> | AVFISPYNSQNYVAARVLGLQTQTVDS | AQGSEYDYVIYTTQSDTAHAL | NVNRFNVAITRAKKGIF | CVMDANLNFNALEFQEIITTT---D-----LQS--VLSGLFKNCIRKGGH-DLPPNHARSFLDLDS | | | | | | | | |
| <i>Mink-CoV</i> | ATFISPYNSQNYVARLLGLQTQTVDS | AQGSEYDFVYTTQSDTAHAVN | LNRFNVAITRAKIGILC | VMCDKAMYDGLNFIYIKDV---N-----LQVKSEGCGLFKDCAKVEH-YIPPAYATTYISLSD | | | | | | | | |
| <i>NL63</i> | AVFISPYNSQNYVASRFLGLQIQTVDS | QGSEYDYVIYAQTSDTAHACN | VNRFNVAITRAKKGIF | CVMDKTLFDSLKFFEIKHA---D-----LHS-SQVCGLFKNCIRTRPL-NLPPTHAHTFSLSD | | | | | | | | |
| <i>NL63-related</i> | AVFISPYNSQNYVASRLLGLQIQTVDS | QGSEYDYVIYAQTSDTAHACN | VNRFNVAITRAKKGIF | CMCDRELFELKFFEIKQS---D-----LQSVDAQCGLFKDCARNPV-DLPPTHAHTFSLSD | | | | | | | | |
| <i>Porcine-EDV</i> | AVFISPYNSQNYVASRLLGLQIQTVDS | QGSEYDYVIYAQTSDTAHASN | VNRFNVAITRAKKGILC | IMCDRSLFDLLKFFELKLS---D-----LQA-NEGCGLFKDCSRGDD-LLPPSHATTFMSLSD | | | | | | | | |
| <i>TGE</i> | AVFISPYNSQNYVARLLGLQIQTVDS | AQGSEYDYVIYTTQSDTQHATN | VNRFNVAITRAKVGILC | IMCDRTMYENLDFYELKDSKIG---D-----LQAKPETCGLFKDCSKSEQ-YIPPAYATTYMSLSD | | | | | | | | |



| | 7250 | 7260 | 7270 | 7280 | 7290 | 7300 | 7310 | 7320 | 7330 | 7340 | 7350 | 7360 | |
|----------------------|---------------|--------------|--------------|--------------|-----------|-----------|---------|----------|------------|------------|----------|------------|----------|
| <i>Bat-BCoV</i> | KFKTNGGLCVHLP | GIKEVSYRRLIS | MMGFKLDYSVQ | DPRLFITRDEAI | KQVR | AWVGF | DVEGAHA | TKDAV | GTNVPLQLGF | STGINFV | ATPTGFVD | TETGTECCRI | FAKPP |
| <i>Bovine-CoV</i> | KYKATGDLAVCL | GIIGDSAVTYS | RRLISLMGFKLD | VTLTDGYCKL | FITKEEA | VKRV | RAWVGF | DAEGAH | ATRDSI | GTNFPLQLGF | STGIDFV | VEATGLFAD | RDRGYSFK |
| <i>Covid-19</i> | KFKTE-GL | CVDIPGIPKDM | TYRRLISMMG | FKMNYOVNG | YPNMFITRE | EAIRHVR | AWVGF | DVEGCH | ATREAV | GTNLPLQLGF | STGVNLV | AVPTGYVD | TPNNTDF |
| <i>GCCDC1</i> | KFKLNE | SMCAHFD | TNEVQMPYI | RLISVMGFR | FDLH | IPGYSKL | FITREQA | IREVRG | WIGFD | VEGTHAC | GPVNTNL | PLQIGF | STGVNFV |
| <i>HKU1</i> | KYKVNENL | AVNLC | EPVLTYS | RRLISLMG | FKLDL | TLDGYSKL | FITKDEA | IKRV | GWVGF | DVEGAHA | TRENI | GTNFPLQ | IGFSTG |
| <i>HKU14</i> | KYKVNENL | AVNLC | EPVLTYS | RRLISLMG | FKLDL | TLDGYSKL | FITKDEA | IKRV | GWVGF | DVEGAHA | TRENI | GTNFPLQ | IGFSTG |
| <i>HKU24</i> | KYKVS | GD | LAVCL | DIAD | STISYS | RRLISLMG | FKLDL | TLDGYCKL | FITKEEA | VKRV | RAWVGF | DSEGAHA | TRDNI |
| <i>HKU4</i> | KYKT | DEL | CVN | LN-IT | PNVTYS | SRVISRM | GFKL | DATIP | GPYKLF | ITRDEA | IRQVRS | WVGF | DVEGAHA |
| <i>HKU5</i> | KYKTS | DEL | CVN | LN-VP | ANVPYS | SRVISRM | GFKL | DASIP | NPYKLF | ITRDEA | IRQVRS | WVGF | DVEGAHA |
| <i>HKU9</i> | KFKLNE | SLCVH | FD | TTELQ | MPYNRLIS | KMGFK | FDL | NIPGYSKL | FITREQA | IREVRG | WVGF | DVEGAHA | CGPNI |
| <i>Hedgehog-CoV</i> | KFKT | NDEL | CVN | LN-IP | ANVSYS | SRVISRM | GFKL | DASIP | NPYKLF | ITKEEA | IRQVRS | WVGF | DVEGAHA |
| <i>MERS-CoV</i> | KYKTS | DEL | CVN | LN-LP | ANVPYS | SRVISRM | GFKL | DATVP | GPYKLF | ITREEA | VRQVRS | WVGF | DVEGAHA |
| <i>MHV</i> | KYKVG | DL | AVCL | NV | ADSAVT | YSRLISLMG | FKLDL | TLDGYCKL | FITRDEA | IKRV | RAWVGF | DAEGAHA | IRDSI |
| <i>OC43</i> | KYKATG | DL | AVCL | GI | IGDSAVT | YSRLISLMG | FKLDL | TLDGYCKL | FITKEEA | VKRV | RAWVGF | DAEGAHA | TRDSI |
| <i>Rat-CoV</i> | KYKVG | DL | AVCL | NV | ADSAVT | YSRLISLMG | FKLDL | TLDGYCKL | FITRDEA | IKRV | RAWVGF | DAEGAHA | TRDSI |
| <i>SARS-CoV</i> | KFKTE-GL | CVDIPGIPKDM | TYRRLISMMG | FKMNYOVNG | YPNMFITRE | EAIRHVR | AWVGF | DVEGCH | ATREAV | GTNLPLQLGF | STGVNLV | AVPTGYVD | TPNNTDF |
| <i>229E</i> | RFKT | SGDL | AVQIG | NNVC-T | YEHVIS | YMGFR | FDVSM | PGSHSL | FCTRDF | FAMRHVR | GWLG | MDVEGAH | VTGDN |
| <i>Bat-CoV-1a</i> | RFKT | SGEL | AVNVG | AKGPC-T | YEHVIS | YMGFR | FDLNP | GYHTL | FCTRDF | FAMRNVR | GWLG | MDVEGAH | VCNSV |
| <i>BtCoV512</i> | NFKT | DKDL | AVQIG | VNGPV-K | YEHVIS | FMGFR | FDIN | VNPQHT | LFC | TRDF | FAMRN | ARGWL | GFDVEGAH |
| <i>BtMr-AlphaCoV</i> | SFKT | SQEL | AVAI | GAPR | DCVRYE | HVISFMG | FRFDV | NPYHT | LFC | TRDF | FAMRHVR | GWIG | MDVEGAH |
| <i>BtNv-AlphaCoV</i> | AFKTD | KDL | AVQIG | VSGTI-K | YEHVIS | FMGFR | FDVNP | PGYHSL | FCTRDF | FAMRNVR | GWIG | MDVEGAH | CGDNL |
| <i>BtRf-AlphaCoV</i> | NFKT | SGDL | AVQIG | SNGVC-K | YEHVIS | FMGFR | DSSIP | PGYHSL | FCTRDF | FAMRHVR | GWIG | MDVEGAH | VGD |
| <i>CDPHE15</i> | NFKT | DKEL | AVQIG | VNGPI-K | YEHVIS | FMGFR | FDVNP | PNHTL | FCTRDF | FAIRHVR | GWLG | MDVEGAH | VGEN |
| <i>FCoV</i> | NFKT | SDGL | AVNIG | TKDV-- | KYANVIS | YMGFR | FEANI | PGYHTL | FCTRDF | FAMRNVR | AWLG | MDVEGAH | CGDNL |
| <i>Ferret-CoV</i> | SFKT | SDGL | AVNVG | TKPV-- | TYASVIS | YMGFR | FDVNP | PGYHTM | FCTRDF | FAMRNVR | AWLG | MDVEGAH | CGDNL |
| <i>HKU10</i> | NFKT | SGDL | AVQIG | VNGVC-K | YEHVIS | FMGFR | FDTNP | PGYHSL | FCTRDF | FAMRHVR | GWLG | MDVEGAH | VGDNL |
| <i>HKU2</i> | KFKT | DKEL | AVNIGH | SDV-- | RYEHVIS | YMGFR | FDMNIP | NHSL | FCTRDF | FAMRNVR | GWIG | MDVEGAH | CGDNL |
| <i>HKU8</i> | RFKT | EGDL | AVQIG | SKTPC-T | YERVVIS | FMGFR | FDLNP | PGYHTL | FCTRDF | FAMRHVR | GWLG | MDVEGAH | VCNSV |
| <i>LuchengRn-CoV</i> | RFKVT | DEL | AVHIG | SSEP-- | TYEHLV | SWMGR | FDAC | PKGYHT | MFC | TRDF | FAIRNVR | GWLG | MDVEGAH |
| <i>Mink-CoV</i> | SFKT | NNGF | AVDV | GNKPV-- | TYASVIS | YMGFR | FDANI | PGYHTL | FCTRDF | FAIRNVR | AWLG | MDVEGAH | CGDNL |
| <i>NL63</i> | QFKT | TGDL | AVQIG | SNNVC-T | YEHVIS | FMGFR | FDISIP | PGSHSL | FCTRDF | FAIRNVR | GWLG | MDVEGAH | CGDNL |
| <i>NL63-related</i> | RFKT | NGDL | AVQIG | SNNVC-T | YEHVMS | FMGFR | FDINIP | PGSHSL | FCTRDF | FAIRNVR | GWLG | MDVEGAH | CGDNL |
| <i>Porcine-EDV</i> | NFKT | DQY | LAVQIG | VNGPI-K | YEHVIS | FMGFR | FDINIP | NHHTL | FCTRDF | FAMRNVR | GWLG | MDVEGAH | VCNSV |
| <i>TGE</i> | NFKT | SDGL | AVNIG | TKDV-- | KYANVIS | YMGFR | FEANI | PGYHTL | FCTRDF | FAMRNVR | AWLG | MDVEGAH | VCNSV |



7370 7380 7390 7400 7410 7420 7430 7440 7450 7460 7470 7480 7490

Bat-BCoV PWNIVRARIVQMMSDTLKGVTDRVVLVTWAHGFELTSMQYFCKLGRERTCCMCAERATCYSSVHDNFCWVHHC---TGF DYLYNPFIVDVQQWGYSGNLQSNHNDHCSVHSGAHVASSDAIMTRCLA

Bovine-CoV RWDVVRPRIVQMFADHLIDLSDCVLVTWAANFELTCLRYFAKVGREISCNVCTKRATAYNSRTGYGCRWHS---VTC DYLYNPLIVDIQQWGYIGSLSSNHDLYSVHKGAHVASSDAIMTRCLA

Covid-19 PWNVVRKIVQMLSDTLKLNLSDRVVFLWAHGFELTSMKYFVKIGPERTCCLCDRRATCFSTASDTYACWVHHS---IGFDYVYNPFMIDVQQWGF TGNLQSNHDAICDVHGNHVAASDAIMTRCLA

GCCDC1 PWSVIRKRIVEMLCDTL DGVSDTVTFVTWAHGFELTTLHYFAKVGPERKCFSCRRATLYSSVYDAYACVTHRHRIIGADYVYNPFVVDVQQWGYVGNLQSNHDAICDVHGNHVAASDAIMTRCLA

HKU1 KWDIVRIRIVQMLSDYLLDLSDSVVFITWSASFELTCLRYFAKLGRELNCNVCSNRATCYNSRTGYGCRWHS---YTC DYLYNPLIVDIQQWGYTGS LTSNHDIICNVHKGAVASADAIMTRCLA

HKU14 RWDVVRPRIVQMFSDHLVDLADSVLVTWAASFELTCLRYFAKIGKETCCNVCTNRATVYNSRTGYGCRWHS---VSC DYLYNPLIVDIQQWGYVGS LSSNHDMYCSIHKGAVASSDAIMTRCLA

HKU24 KWEVVRIRIVQMLSDHLVDLADSVVFTWAANFELTCLRYFAKIGKETCCNVCTNRATVYNSRTGYGCRWHS---LSC DYLYNPLIVDIQQWGYTGS LSSNHDMYCSVHKGAVASSDAIMTRCLA

HKU4 TPWIVRRRIVQMLSDTLDKLSDYCTFVCAHGFELTSASYFCKIGKEQRCMCSRRASTFSSPLQSYACWVSHS---SGDYVYNPFVVDVQQWGYVGNLATNHDRYCGIHAGAHVASSDAIMTRCLA

HKU5 AWPIVRRRIVQMLSDTLDKLSDYCTFVCAHGFELTSASYFCKIGKEQRCMCSRRASTFSSPLQSYACWVSHS---SGDYVYNPFVVDVQQWGYIGNLATNHDRYCSVHQAHVASSDAIMTRCLA

HKU9 PWSVVRKRIVEMLCDTL DGVSDTVTFVTWAHGFELTTLHYFAKVGPERKCFMCPRRATLFSVYGAYSWVSHRHRIIGADYVYNPFVVDVQQWGYVGNLQSNHDAICDVHGNHVAASDAIMTRCLA

Hedgehog-CoV AWPVRRRIVQMVSDTLDKLSDHCTFVCAHGFELTSASYFCKIGKEQKCCMNRRAAGAYSSPLHSYACWAHS---SGDYVYNPFVVDVQQWGYVGNLATNHDRYCTLHQGAHVASNDAIMTRCLA

MERS-CoV AWPIVRRRIVQMLSDTLDKLSDYCTFVCAHGFELTSASYFCKIGKEQKCCMNRRAAYSSPLQSYACWVTHS---CGDYVYNPFVVDVQQWGYVGNLATNHDRYCSVHQAHVASSDAIMTRCLA

MHV KWDVVRIRIVQMLSDHLVDLADSVLVTWAASFELTCLRYFAKVGREVVSVCTKRATCFNSRTGYGCRWHS---YSC DYLYNPLIVDIQQWGYTGS LTSNHDPICSVHKGAVASSDAIMTRCLA

OC43 RWDVVRPRIVQMFADHLIDLSDCVLVTWAANFELTCLRYFAKVGREISCNVCTKRATVYNSRTGYGCRWHS---VTC DYLYNPLIVDIQQWGYIGSLSSNHDLYSVHKGAHVASSDAIMTRCLA

Rat-CoV KWDVVRIRIVQMLSDHLVDLADSVLVTWAASFELTCLRYFAKVGREVVSVCTKRATCFNSRTGYGCRWHS---YSC DYLYNPLIVDIQQWGYTGS LTSNHDPICSVHKGAVASSDAIMTRCLA

SARS-CoV PWNVVRKIVQMLSDTLKGLSDRVVFLWAHGFELTSMKYFVKIGPERTCCLCDKRATCFSTSSDTYACWNHS---VGF DYLYNPFMIDVQQWGF TGNLQSNHDOHCVHGNHVAASDAIMTRCLA

229E PWSVLRKRIVQMIADFLAGSSDVLVFLWAGGLELTMRYFVKIGAVKHC-QCGTVATCYNSVSNDYCFKHA---LGC DYLYNPNYVIDIQQWGYVGS LSNHHAI CNVHRNEHVASGDAIMTRCLA

Bat-CoV-1A PWSVVRKRIVQMCCDYISTSSDVIIFVLWAGGLELTMRYFVKVGPRI DC-HCSKVATCYNSVEHQYCFKHA---MGC DYIYNPYVIDIQQWGYTGS LSSNHQHCVNHRNEHVASGDAIMTRCLA

BtCoV512 PWSVIRRRIVQMCDYLANLSDTLIFVLWSSGGLLELTMRYFVKLGVPQTC-DCGKRATCYNSTNHTFSCFRHA---LGC DYIYNPYVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

BtMr-AlphaCoV PWNVRRRIVQMVCDLKLSDVVFVFLWAGGLELTMRYFVKIGIAQHC-YCGKDARCYNATHSFCYFNHA---TGC DYLYNPFVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

BtNv-AlphaCoV PWSVVRKRIVQMCCDMSGMSDIIIFVLWAGGLELTMRYFVKIGPVTHC-HCGKEATCYNSGSHAFYCFRHA---LGC DYLYNPFVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

BtRf-AlphaCoV PWSVVRKRIVQMCCDYL SGLSDVLVFLWAGGLELTMRYFVKVGPVKHC-HCGKEATCYNSVHAFYCFKHA---LGC DYLYNPNYVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

CDPHE15 PWSVVRKRIVQMCCDHFINLSDIVFVFLWSSGGLLELTMRYFVKVGPVKHC-ECGKLATCYNSVSHSFCYFTHA---FGC DYLYNPNYVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

FCoV PWHIVRRRIVQMVCDYFDGLSDILIFVLWAGGLELTMRYFVKIGRPQKC-ECGKSATCYSSQCVYACFKHA---LGC DYLYNPNYVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

Ferret-CoV AWSIVRRRIVQMVCDYFEGLSDIVIFVLWAGGLELTMRYFVKIGEQKDC-DCGIIAACYNQAQTYRCMKHA---LGC DYLYNPFVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

HKU10 PWNVVRKRIVQMCCDYL SGLSDVLVFLWAGGLELTMRYFVKVGPVKHC-HCSKESTCYNSTTHEYCFKHA---LGC DYLYNPFVIDIQQWGYTGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

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LuchengRn-CoV PWAVVRKRIVQMVCDHLKDLSDVVFVFLWAGGLELTMRYFVKIGPPRNC-HCGRVAQCYSSNAVAFSCLRHA---VGC DYLYNPNYAFDIQQWGYTGS LSNHHRVCNVHFNEHVASGDAIMTRCLA

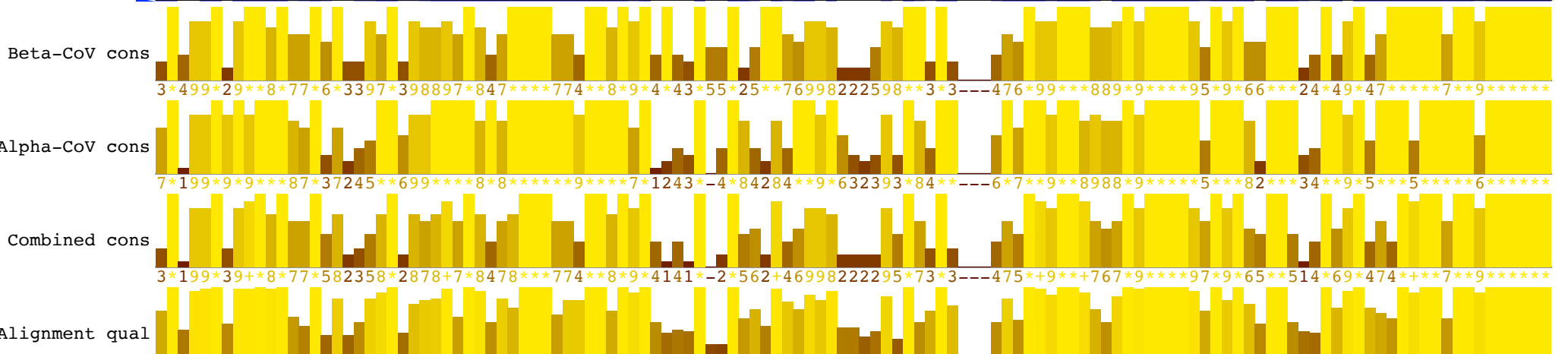
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NL63 PWLIVRRRIVQMISDYLNSLSDILIFVLWAGGLELTMRYFVKIGPIKYC-YCGNSATCYNSVSNYCCFKHA---LGC DYLYNPNYAFDIQQWGYVGS LSNHHTFCNIHRNEHDASGDAIMTRCLA

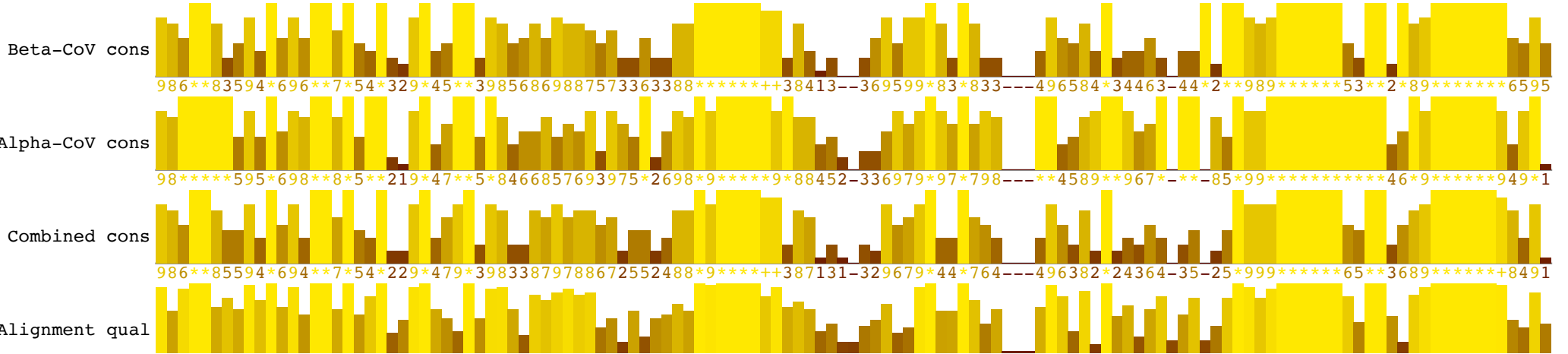
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Porcine-EDV PWDVVRKRIVQMCDYLANLSDILIFVLWAGGLELTMRYFVKIGPSKSC-DCGKVATCYNSALHTYCFKHA---LGC DYLYNPNYVIDIQQWGYKGS LSNHHEVCNIHRNEHVASGDAIMTRCLA

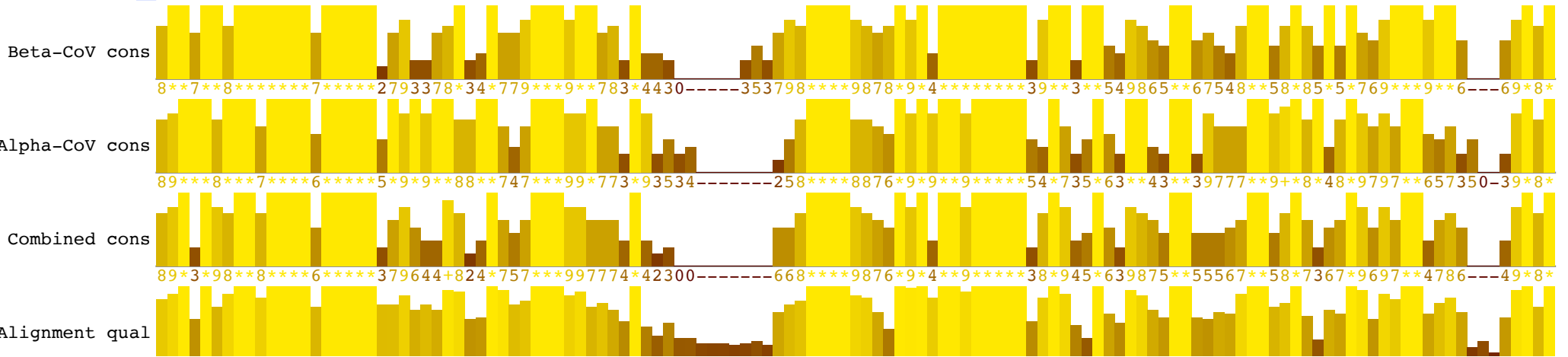
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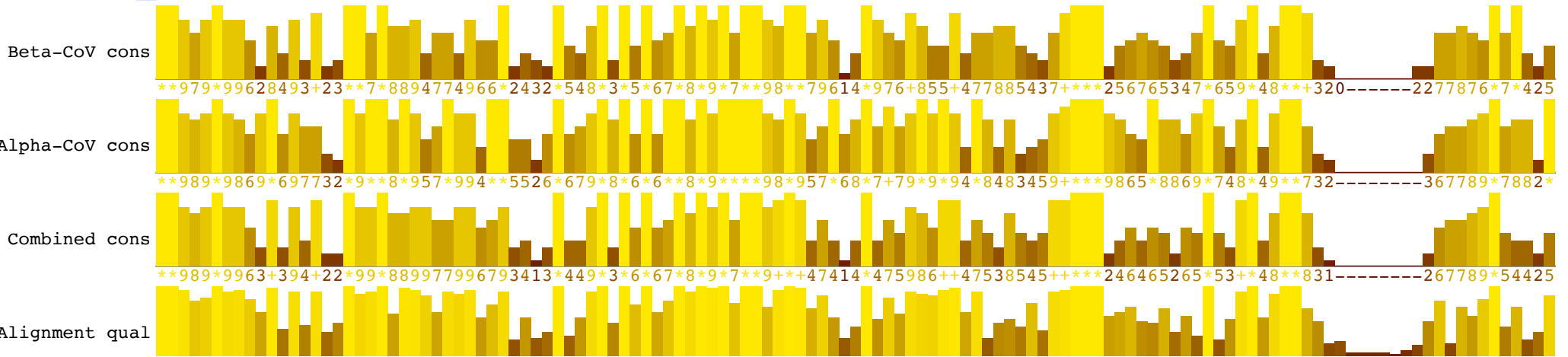
| | 7500 | 7510 | 7520 | 7530 | 7540 | 7550 | 7560 | 7570 | 7580 | 7590 | 7600 | 7610 | | | |
|----------------------|-------------------|-----------------|----------------|-----------------|---------------|-------------------|-----------------|---------------|--------------|------------|--------------|----------------|--------------|--------------|------------------|
| <i>Bat-BCoV</i> | IYDCFVKEVHWDIEYPI | IADEEFINKSCRKVN | MMVARAALLGDKFG | TTHDIGNPKALKCVL | DAEVDNWKFYDAK | PVAGRAHKVETLY | QYQYEVHKDQFQ | QDGVCMFWNCNVD | HYPKNSIVCRFD | TRSLSK | | | | | |
| <i>Bovine-CoV</i> | VYDFCFCNNINWNVE | YPIISNELSINTS | CRVLRQVMLKAAM | LCNRYTLCYDIGN | PKAIACVVDK-- | FDKFKYDAQPIV | K---SVKTL | LLYSFEAHKDS | FKDGLCMFWNC | NDKYPNAV | VCFRDTRVLNN | | | | |
| <i>Covid-19</i> | VHECFVKRVDWTIE | YPIIGDELKINA | ACRQVHMVKAAL | LADKFPVLHDIGN | PKAICVQADVEW | KFYDAQPCSDK | KAYKIEELFYS | YATHSDKFTD | GVCLFWNCNVD | RYPANSIVCR | FDTRVLSN | | | | |
| <i>GCCDC1</i> | IHDCFCREVNWDIE | YPIISNELAINK | SCRVVQLVLA | VTRAMHVTTIYD | IGNPKAIRVPGV | DVKRWKFDCKPI | AN---GVETL | HSYAIHKDQF | ADGLTMFWNC | NDCYPNNA | IVCRFDTRVLSK | | | | |
| <i>HKU1</i> | IYDFCCKSVNWNLE | YPIISNEVSINT | SCRLLQVMLKAAM | LCNRYNLCDIGN | PKGLACVVDK-- | YEFKFDAPVAK | ---SVKQLF | YVYDVHKDN | FKDGLCMFWNC | NDKYPNSI | VCFRDTRVLNK | | | | |
| <i>HKU14</i> | VYDFCFCNNINWN | VEYPIISNELS | INSSCRTLQV | MLKAAMLCNRY | SLCYDIGNPKA | IACIKG--YDF | KFYDAQPIV | K---SVKTL | FYSYEAHKD | SFKDGLCM | FWNCNDKYP | NAVVCFRDTRVLNN | | | |
| <i>HKU24</i> | VYDFCFCNNVNW | NLEYP | IISNELVINSS | RALQVMLKAAM | LCNRYSLCYD | IGNPKAIACVVDK-- | FDKFKYDAK | PLVK---AVK | TLYTYDAHK | SFKDGLCM | FWNCNDKYP | NAVVCFRDTRVLSK | | | |
| <i>HKU4</i> | IYDFCIERVDWD | VTPYISHEQKL | NSCRTVERN | VRSVAVLSGK | FEKIYDIGNPK | GAIISEP-V | VEWHFYDAQ | PLSN---K | VKKLFYTD | DVS-KQF | EDGLCLFWNC | NSKYPNAV | VCFRDTRVHSE | | |
| <i>HKU5</i> | IHDCFIERVEWD | ITYPISHEKRL | NSCRAVERN | VRAALLAGR | FERYDIGNPK | GIPIVDDP | VVDWHYDAQ | PLSK---K | VQQLFYT | EDCA-KNF | SDGLCLFWNC | NDKYPNA | IVCRFDTRVHSE | | |
| <i>HKU9</i> | IHDCFCGEVNWD | VEYPIIANEL | AINRACSVQ | RVVLAAVKAL | HIEITYDIGN | PKAIVYGVN | VNNWNFYD | TNPVVE--- | GVKQLHY | VYDVHRD | QFKDGLAM | FWNCNVD | CYPHNA | IVCRFDTRVLSK | |
| <i>Hedgehog-CoV</i> | VHSCFIERVDWD | IEYPIISHEQ | LNSFCRIVER | NVRAALLAG | GFNVYDIGN | PKGIPIVED | PVVDWHYDA | QPLRK--- | NVKQLFY | TDAMA-S | DFS | DGLCLFWNC | NPYPNA | IVCRFDTRVHSE | |
| <i>MERS-CoV</i> | IHSCFIERVDWD | IEYPIISHEK | LNSC RIVER | NVRAALLAG | SFDKVDIGN | PKGIPIVDD | PVVDWHYDA | QPLTR--- | KVQQLFY | TEDMA-S | RFADGL | CLFWNC | NPYPNA | IVCRFDTRVHSE | |
| <i>MHV</i> | VHDCFCCKSVN | WNLEYP | IISNEVSINT | SCRLLQV | MFRAMLCN | RYDVCYDIGN | PKGLACVVDK-- | YDFKFD | ASPVVK--- | SVKQFV | YKYEAHK | DQFLDGL | CMFWNC | NDKYPANAV | VCFRDTRVLNK |
| <i>OC43</i> | VYDFCFCNNIN | WNVEYPI | IISNELSINT | SCRVLRQ | VILKAAM | LCNRYTLCYD | IGNPKAIACVVDK-- | FDKFKY | DAQPIV | K---SVK | TLLYSFE | AHKDSFK | DGLCM | FWNCNDKYP | NAVVCFRDTRVLNN |
| <i>Rat-CoV</i> | VHDCFCCKSVN | WNLEYP | IILNEVSINT | SCRLLQV | MFRAMLCN | RYDVCYDIGN | PKGLACVVDK-- | YDFKFD | ASPVVK--- | SVKQFV | YKYEAHK | DQFLDGL | CMFWNC | NDKYPANAV | VCFRDTRVLNK |
| <i>SARS-CoV</i> | VHECFVKRVDWS | VEYPIIGDEL | RVNSACRQV | HMVKSALLAD | KFPVLHDIGN | PKAICVQAD | VEWKFYDAQ | PCSDKAYKIE | EELFYS | YATHSDK | FTDGVCL | FWNCNVD | RYPANA | IVCRFDTRVLSN | |
| <i>229E</i> | VYDFVKNVDWS | ITYPIMANENA | INKGGR | TQSHIMRAA | IKLYNPKA | IHDIGNPKG | IRCAVTD-A | KWYCYDK | NPINS--- | NVKTLE | YDYMT | H-GQ-ME | GLCLFWNC | NVDMY | PEFSIVCRDTRTRST |
| <i>Bat-CoV-1A</i> | IYDFVKNVDWS | ITYPFIGNEA | AINKGGR | VQSHIVKAA | IKVYNPKV | IHDIGNPKG | IRCAVTN-S | TGYSYDK | QPLNS--- | NVKTLE | YDYLH | H-GQ-MD | GLCLFWNC | NVDMY | PEFSVVCFRDTRCKST |
| <i>BtCoV512</i> | IHDCFVKNVDWS | ITYPFIANE | QAINSGRL | VQSHVRAV | LKLYNPKA | IHDVGNPKG | IRCVVTD-A | SWCYDK | NPTNT--- | NVKMLE | YDYI | H-GQ-LD | GLCLFWNC | NVDMY | PEFSVVCFRDTRMRST |
| <i>BtMr-AlphaCoV</i> | VYDFVKNVDWS | ITYPFI | CNESVNVK | SGRVQSHIM | RAALVVD | PVAIHVGNPKG | IRCAVTS-K | PWYCYDK | QPLNS--- | NVRCLE | YDYI | H-GQ-MN | GLCLFWNC | NVDMY | PEFSIVCRDTRCKSA |
| <i>BtNv-AlphaCoV</i> | VYDFVKNVDWS | ITYPFI | SNELAINK | SGRVQSHI | VRAALKLYN | PKAHDIGNPKG | IRCASTN-I | SWCYDK | QPLNS--- | NVRMLE | YDYI | H-GQ-ME | GLCLFWNC | NVDMY | PEFSIVCRDTRRSV |
| <i>BtRf-AlphaCoV</i> | IHDCFVKNVDWS | ITYPFI | SNERAIN | SGRMVQRH | LMAVLKLY | KPEAHDIGNPKG | IRCAVSD-A | KWYCYDK | QPLNS--- | NVKLFE | YDYI | H-GQ-LN | GLCLFWNC | NVDMY | PEFSVVCFRDTRCRSN |
| <i>CDPHE15</i> | IYDFVKNVDWS | ITYPFI | ANENLINK | SGRMVQSH | VRAALALY | KPKAHDIGNPKG | IRCAVTD-V | SWCYDK | QPLNN--- | NVKTLE | YDYI | H-GQ-FD | GLCLFWNC | NVDMY | PEFSIVCRDTRQSL |
| <i>FCoV</i> | IHDCFVKRVDWS | ITYPFI | DNEEKINK | AGRIVQSH | VMAALKIF | NPAIHDVGNPKG | IRCATTP-I | PWFCYDR | DPINN--- | NVRCLE | YDYM | VH-GQ-MN | GLMLFWNC | NVDMY | PEFSIVCRDTRTRSK |
| <i>Ferret-CoV</i> | IHDCFVKRVDWS | ITYPFI | DNEESINK | AGRIVQSH | VRAAISV | LNPSIHDVGNPKG | IRCVTTS-L | PWFCYDK | DPINS--- | NVRCLE | YDFI | H-GQ-MP | GLMLFWNC | NVDMY | PEQSIVCRDTRTRSK |
| <i>HKU10</i> | IHDCFVKSLDWS | ITYPFI | ANEREIN | SGRVQRM | LMTAIKLYN | PKAHDIGNPKG | IRCAVTD-A | KWYCYDR | QPLNS--- | NVKLFE | YDYI | H-GQ-LD | GLCLFWNC | NVDMY | PEFSIVCRDTRCRSS |
| <i>HKU2</i> | IHDCFVKNVDWS | ITYPFI | ANENAINK | SGRIVQSH | IMKAALKV | YNPKAVHDIGNPKG | IRCAATN-V | PWYCYDK | QPLNS--- | NVKMLE | YDYM | H-GQ-LD | GMCLFWNC | NVDMY | PEFSIVCRDTRCRSH |
| <i>HKU8</i> | IYDFVKNVDWS | ITYPFI | GNEAAIN | RSGRIVQ | SHAVKAA | LKLYNPKAHDIGNPKG | IRCAVTD-A | SWCYDK | NPISS--- | NVKTLE | YDYL | VH-GQ-FD | GLCLFWNC | NVDMY | PEFSVVCFRDTRCKSA |
| <i>LuchengRn-CoV</i> | IYDFVKDVHWD | ITYPFI | ANESDINA | AGRYVERH | LMTFVKLYN | PKAIDVGNPKG | IRICDFK-G | SWCYDK | KEPTNN--- | NVKLE | YDYTV | H-GQ-FD | GLCLFWNC | NVDMY | PGFSLVCRFDTKHRSP |
| <i>Mink-CoV</i> | VHDCFVKRVDWS | ITYPFI | DNEATINK | AGRIVQSH | VRAAIK | VLNPSAIHDVGNPKG | IRCVTTP-L | PWFCYDK | DPINS--- | NVRCLE | YDFI | H-GQ-MP | GLMLFWNC | NVDMY | PECSVVCFRDTRTRSK |
| <i>NL63</i> | VHDCFVKNVDW | TVTPFI | ANEKFI | NGCGRNV | QGHVRAA | LKLYKPSVIHDIGNPKG | IRCAVTD-A | KWYCYDK | QPVNS--- | NVKLLD | YDYA | H-GQ-LD | GLCLFWNC | NVDMY | PEFSIVCRDTRTRSV |
| <i>NL63-related</i> | IHDCFVKNVDW | TVTPFI | ANEKSI | NGCGRNV | QGHVRAA | LKLYKPSVIHDIGNPKG | IRCAVTD-A | RWYCYDK | QPVNS--- | NVKLLE | YDYM | H-GQ-LD | GLCLFWNC | NVDMY | PEFSIVCRDTRTRSV |
| <i>Porcine-EDV</i> | IHDCFVKNVDWS | ITYPFI | GNEAVINK | SGRIVQSH | TMRSVL | KLYNPKAIDVGNPKG | IRCAVTD-A | KWYCYDK | NPNTS--- | NVKTLE | YDYI | H-GQ-FD | GLCLFWNC | NVDMY | PEFSVVCFRDTRCRSP |
| <i>TGE</i> | IHDCFVKRVDWS | ITYPFI | DNEEKINK | AGRIVOSH | VMAALKIF | NPAIHDVGNPKG | IRCATTP-I | PWFCYDR | DPINN--- | NVRCLE | YDYM | VH-GQ-MN | GLMLFWNC | NVDMY | PEFSIVCRDTRTRSK |



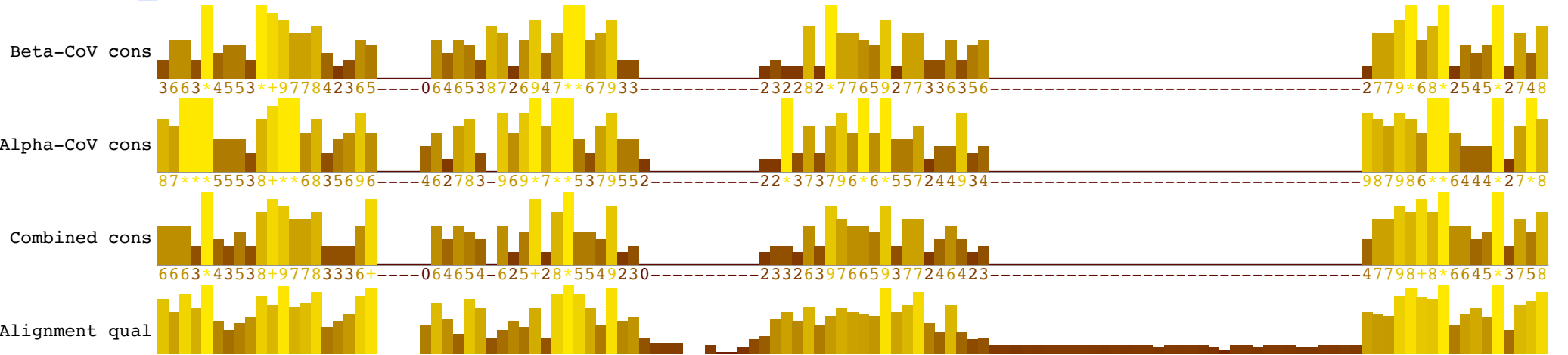
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|----------------------|---------------|------------|-------------|------------|---------------|------------|-----------------|-------------|---------------|---------------|-------------|-----------|------------|----------|-------------|-------------|-------------|
| <i>Bat-BCoV</i> | LNLPGCDGGS | LYVNKHAFHT | PAFQKSAF | TDLQQLPFF | FYSDTECDST | ---GQQV | VADIN | VVPLKSNVC | ITRCNLGGAVC | KKHANEYREYL | TCYNAVIEAGF | SLWIYKWF | NINYLWSTFT | ---KLQGL | | | |
| <i>Bovine-CoV</i> | LNLPGCNGGS | LYVNKHAFHT | KPFSSRAAF | EHLKMPFF | FYSDTPCVYMDGM | ---DAKQ | VDYVPLKSATC | ITRCNLGGAVC | CLKHAEYREYLES | SYNTATTAGFT | TFWVYKTFDF | YNLWNTFT | ---KLQSL | | | | |
| <i>Covid-19</i> | LNLPGCDGGS | LYVNKHAFHT | PAFQKSAF | VNLKQLPFF | FYSDSPCESH | ---GKQV | VSDDIDYVPLKSATC | ITRCNLGGAVC | RRKHANEYRL | YLDAYNMMISAGF | SLWVYKQFD | TYNLWNTFT | ---RLQSL | | | | |
| <i>GCCDC1</i> | LNLACGNGGS | LYVNQHAFHT | PAYNKSFAF | VNLKPLPFF | FYSDTPCENAI | GMSTDFVCDV | YVPLKSNVC | ITRCNLGGAVC | KKHADEYRQFL | EYNTMVSAGF | TLWVDKDFV | FNLWSTFT | ---KLQSL | | | | |
| <i>HKU1</i> | LNLPGCNGGS | LYVNKHAFHT | NPFFTRTV | FENLKPMPFF | FYSDTPCVYVDGL | ---ESKQ | VDYVPLRSATC | ITRCNLGGAVC | SKHAEYCNYLES | YNIVTTAGFT | TFWVYKNFDF | YNLWNTFT | ---TLQSL | | | | |
| <i>HKU14</i> | LNLPGCNGGS | LYVNKHAFHT | NPFFSRAAF | EYLYKMPFF | FYSDTPCVYMDGM | ---DNKQ | VDYVPLKAATC | ITKCNLGGAVC | CLKHAEYREYLE | CYNTATTAGFT | TFWVYKTFDF | YNLWNTFT | ---KLQSL | | | | |
| <i>HKU24</i> | LNLPGCNGGS | LYVNKHAFHT | PPFIRAAF | EYLYKMPFF | FYSDTPCVYMEGI | ---DVKQ | VDYVPLKSATC | ITRCNLGGAVC | CLKHAEYREYLE | CYNTATTAGFT | TFWVYKTFE | YNLWNTFT | ---QLQSL | | | | |
| <i>HKU4</i> | FNLPGCNGGS | LYVNKHAFHT | PAYDINAF | RDLKPLPFF | FYSTTPCEVHG | ---SGNML | EDIDYVPLKSAVC | ITACNLGGAVC | RRKHAEYRDY | MEAYNIVSAGF | RWLWVYKTFD | IYNLWSTFV | ---KVQGL | | | | |
| <i>HKU5</i> | FNLPGCDGGS | LYVNKHAFHT | PAYDASAF | RDLKPLPFF | FYSTTPCEVHG | ---NGNML | EDIDYVPLKSAVC | ITACNLGGAVC | RRKHAEYRDY | MEAYNLVSAGF | RWLWVYKTFD | IYNLWSTFT | ---KIQGL | | | | |
| <i>HKU9</i> | LNLACGNGGS | LYVNQHAFHT | DAFNKNAF | VNLKPLPFF | FYSDTACENAT | GVSTNYVSEV | YVPLKSNVC | ITRCNLGGAVC | KKHADEYRNFL | ESYNTMVSAGF | TLWVDKTFD | VFNLWSTFV | ---KLQSL | | | | |
| <i>Hedgehog-CoV</i> | FNLPGCNGGS | LYVNKHAFHT | PAYDVSAF | RNLKMPFF | FYSTTPCEVHG | ---TGSML | EDIDYVPLKSAVC | ITACNLGGAVC | RRKHAEYREY | VEAYNLVSAGF | RWLWVYKTFD | IYNLWSTFS | ---RVQGL | | | | |
| <i>MERS-CoV</i> | FNLPGCDGGS | LYVNKHAFHT | PAYDVSAF | RDLKPLPFF | FYSTTPCEVHG | ---NGSMI | EDIDYVPLKSAVC | ITACNLGGAVC | RRKHAEYREY | MEAYNLVSAGF | RWLWVYKTFD | IYNLWSTFT | ---KVQGL | | | | |
| <i>MHV</i> | LNLPGCNGGS | LYVNKHAFHT | SPFTRAAF | FENLKPMPFF | FYSDTPCVYMEGM | ---ESKQ | VDYVPLRSATC | ITRCNLGGAVC | CLKHAEYREYLES | SYNTATTAGFT | TFWVYKTFDF | YNLWNTFT | ---RLQSL | | | | |
| <i>OC43</i> | LNLPGCNGGS | LYVNKHAFHT | KPFARAAF | EHLKMPFF | FYSDTPCVYMDGM | ---DAKQ | VDYVPLKSATC | ITRCNLGGAVC | CLKHAEYREYLES | SYNTATTAGFT | TFWVYKTFDF | YNLWNTFT | ---KLQSL | | | | |
| <i>Rat-CoV</i> | LNLPGCNGGS | LYVNKHAFHT | SPFTRAAF | FENLKPMPFF | FYSDTPCVYMEGM | ---ESKQ | VDYVPLRSATC | ITRCNLGGAVC | CLKHAEYREYLES | SYNTATTAGFT | TFWVYKTFDF | YNLWNTFT | ---RLQSL | | | | |
| <i>SARS-CoV</i> | LNLPGCDGGS | LYVNKHAFHT | PAFDKSAF | TNLKOLPFF | FYSDSPCESH | ---GKOV | VSDDIDYVPLKSATC | ITRCNLGGAVC | RRKHANEYROYL | DAYNMMISAGF | SLWIYKQFD | TYNLWNTFT | ---RLQSL | | | | |
| <i>229E</i> | LNLEGVNGGS | LYVNNHAFHT | PAYDKRAMAKL | KPAPFF | YDDGSC | EVVHD | -----QVNY | VPLRATNC | ITKCNIGGAVC | SKHANLYRAY | VESYNI | FTOAGFNI | WVPTTFD | CYNLWQTF | TDV-NLQGL | | |
| <i>Bat-CoV-1A</i> | FNLEGVNGGS | LYVNNHAFHT | PAFDKRAFAKL | KQAPFF | YDDGDC | DSVQG | -----SVNY | VPLRASNC | ITRCNIGGAVC | NKHANMYSY | VNAYNTYV | QAGFTI | WVNSFD | TYNLWQTL | VTP-QLQSL | | |
| <i>BtCoV512</i> | LNLEGCNNGGS | LYVNNHAFHT | PAYDKRAFAKL | KAMPFF | YDDSECE | KLQD | -----AVNY | VPLRASNC | ITRCNVGGAVC | SKHCALYHN | YVMAYN | FTT | AGFTI | WVNSFD | MFNLWQTF | KNS-NVQGL | |
| <i>BtMr-AlphaCoV</i> | LNLEGCNNGGS | LYVNNHAFHT | PAFDKRAFAKL | KVMPFF | YDTSDC | DKVQE | -----HVNY | VPLRANNC | ITRCNIGGAVC | SKHADMYK | KYVEAYNT | F | TOAGFTI | WCPTS | FDVYNLWQ | SFTTS-NLQGL | |
| <i>BtNv-AlphaCoV</i> | LNLEGVNGGS | LYVNNHAFHT | PAYDKRAFAKL | QPAPFF | YDDGDC | DIVQG | -----ETNY | VPLRASSC | ITRCNVGGAVC | SKHSNMYH | AVNAYN | VFTQAGFTI | WVNSF | ELFNLWQ | TLVDT-NLQGL | | |
| <i>BtRf-AlphaCoV</i> | LNLEGCNNGGS | LYVNKHAFHT | PAFDKRAFAKL | KPAPFF | YDDGPC | ERVQD | -----EVNY | VPLRASNC | ITRCNIGGAVC | SAHAAKYH | DYVGA | NSFVQAGFT | TLWVNS | FDL | FNLWQTF | FAET-NLQGL | |
| <i>CDPHE15</i> | LNLEGCNNGGS | LYVNNHAFHT | PAFDKRAFAKL | KAMPFF | YDTSDC | DKLHD | -----SINY | VPLKASNC | ITRCNVGGAVC | SRHADQYH | SYVAAYN | NFTQAGFTI | WVNSF | DL | FNLWQTL | LAKP-NLQGL | |
| <i>FCoV</i> | LSLEGCNNGGALY | VNNHAFHT | PAYDRRAFAKL | KMPFF | YDSDN | CELVDG | -----QPNY | VPLKSNVC | ITKCNIGGAVC | KKHAALYR | AYVEDYN | MFQAGFTI | WVNSF | DTYML | LWHGFVNS | KALQSL | |
| <i>Ferret-CoV</i> | LSLEGCNNGGALY | VNNHAFHT | PAYDRRAFAKL | KMPFF | YDSD | CDVIDG | -----QPNY | VPLKSNVC | ITKCNIGGAVC | RRKHAEYR | KYVEDYN | MFVQAGFNI | WVNSF | DTYTL | WHSFVNS | KALQSL | |
| <i>HKU10</i> | LNLEGTNGGS | LYVNKHAFHT | PAFDKRAFAKL | KPAPFF | YDDGPC | DRIQE | -----EINY | VPLRANNC | ITRCNIGGAVC | STHAKQYD | YVNAYNSY | TOAGFTL | WVNSF | DL | FNLWQTF | FADT-KLQSL | |
| <i>HKU2</i> | LSLEGVNGGALY | VNNHAFHT | PAYDKRAFAKL | KMPFF | YDDGEC | DVSQG | -----QINY | VPLRATVC | ITRCNIGGAVC | RRKHAEYR | AYVEAYNT | F | TOAGFNI | WVNSF | FDVYNLWQ | TLVDT-NLQGL | |
| <i>HKU8</i> | FNLEGVNGGS | LYVNNHAFHT | PAFDKRAFAKL | KAI | PFF | YDDGEC | DSQCG | -----SINY | VPLHASNC | VTRCNIGGAVC | SKHANMYY | AVNAYNT | F | TOAGFTI | WVNSF | DVYNLWQ | TLVTP-KLQSL |
| <i>LuchengRn-CoV</i> | LSLEGVNGGCLY | VNKHAFHT | PAFDRRALAKL | QALPFF | FDDSD | CDVSDA | ---ESSE | VDYVPLRSNVC | ITKCNVGGAVC | KKHASLYK | TYVQKYN | EFTQNGFTL | WGPQNF | DL | FNLWQ | LVSKP-ILQGL | |
| <i>Mink-CoV</i> | LSLEGCNNGGALY | VNNHAFHT | EAYDRRAFAKL | KPLPFF | FDDST | CELVDG | -----QPNY | VPLKSNVC | ITRCNIGGAVC | KKHAALYR | KYVEDYNT | FVQAGFTI | WVNSF | DTYTL | WQGFVNS | KALQSL | |
| <i>NL63</i> | FNLEGVNGGS | LYVNKHAFHT | PAYDKRAFV | KLKMPFF | YDSD | CDVVQE | -----QVNY | VPLRASSC | VTRCNIGGAVC | SKHANLYQ | KYVEAYNT | F | TOAGFNI | WVNSF | FDVYNLWQ | IFIET-NLQSL | |
| <i>NL63-related</i> | LNLEGVNGGS | LYVNKHAFHT | PAFDKRALAKL | KMPFF | YDDGEC | DVQGE | -----QVNY | VPLRASNC | VTRCNIGGAVC | SKHANLYR | NYVEAYNT | F | TOAGFNI | WVNSF | FDVYNLWQ | TFAET-NLQSL | |
| <i>Porcine-EDV</i> | LNLEGCNNGGS | LYVNNHAFHT | PAFDKRAFAKL | KMPFF | YDDTEC | DKLQD | -----SINY | VPLRASNC | ITKCNVGGAVC | SKHCAMYH | SYVNAYNT | F | TSAGFTI | WVNSF | DTYNLWQ | TFSN--NLQGL | |
| <i>TGE</i> | LSLEGCNNGGALY | VNNHAFHT | PAYDRRAFAKL | KMPFF | YDSDN | CELVDG | -----OPNY | VPLKSNVC | ITKCNIGGAVC | KKHAALYR | AYVEDYNI | F | MOAGFTI | WVNSF | DTYML | LWHGFVNS | KALQSL |



| | 7750 | 7760 | 7770 | 7780 | 7790 | 7800 | 7810 | 7820 | 7830 | 7840 | 7850 | 7860 | 7870 |
|----------------------|----------|---------|---------|---------|---------|---------|--------|---------|--------|--------|---------|--------|--------|
| <i>Bat-BCoV</i> | ENVAYNVV | NKGFHDG | TQGEIPT | AVIGDKV | FVKREGV | DVCFVFN | NNTTLP | TNVAFEL | YAKRNV | NPVPEV | KLLRNIG | VDI | NGFTLW |
| <i>Bovine-CoV</i> | ENVVYLV | VKTGHYT | GQAGEM | PCAIIND | KVVAKID | KEDVVI | FINNTT | YPTNV | AVELFA | KRSIRH | HPPEL | KLFRNL | LNIDV |
| <i>Covid-19</i> | ENVAFNV | VVKNKGF | HFDGQ | QGEVPS | IINNTV | YTKVDG | VDFEL | FENKTL | LPNVAF | ELWAKR | NIKPV | PEVKIL | LNGLV |
| <i>GCCDC1</i> | ENVAYNV | VVKS | SHYTAI | PGELP | VAVND | KLYV | KDEGY | DKLLFT | NKTC | LPNVAF | ELWAKR | SVKVP | PECKLL |
| <i>HKU1</i> | ENVIYN | LVNV | GHYD | GRTGEL | PCAIM | NDKVV | KINNV | DTVIF | KNNTS | FPNTI | AVELF | TKRSIR | HHP |
| <i>HKU14</i> | ENVVYLV | VKTGHYT | GQTGEM | PCAIIND | KVVAKIE | QEDVVI | FNNTT | YPTNI | AVELF | AKRSVR | HHP | PELKL | LRNL |
| <i>HKU24</i> | ENVVYLV | VKTGA | FTEGEM | PCAIR | NDKVF | AKIEQ | DVLF | VFNNT | TFPTN | VAVEL | FAKRSV | RHHP | PELKL |
| <i>HKU4</i> | ENIAFN | VIKQ | GHFTG | VGDGEL | PVAVN | DKIFT | KNGT | DDVC | IFKNE | TALPTN | VAFEL | YAKRA | VRSH |
| <i>HKU5</i> | ENIAYN | VIKQ | GHFTG | VEGEL | PVAVN | DKIY | TKSD | VNDV | CIFEN | KTTLP | NVAF | ELYAKR | AVRSH |
| <i>HKU9</i> | ENVAYN | VLK | SGHFT | AVAGEL | PVAIL | NDRLY | IKED | GADK | LLFTN | NTCL | PTNV | AVEL | WAKR |
| <i>Hedgehog-CoV</i> | ENIAFN | VVKH | GHFKG | VEGEL | PVAVN | DKIFT | KSGV | NDCV | FENK | TNLPTN | VAFEL | YAKRA | VRSH |
| <i>MERS-CoV</i> | ENIAFN | VVKQ | GHFIG | VEGEL | PVAVN | DKIFT | KSGV | NDCM | FENK | TTLPTN | VAFEL | YAKRA | VRSH |
| <i>MHV</i> | ENVVYLV | NAGH | FEDGR | AGELP | CAVIG | EKVI | AKIQ | NE | DVVV | FKNNT | PFPTN | VAVEL | FAKRS |
| <i>OC43</i> | ENVVYLV | VKTGHYT | GQAGEM | PCAIIND | KVVAKID | KEDVVI | FINNTT | YPTNV | AVELFA | KRSIRP | HPPEL | KLFRNL | LNIDV |
| <i>Rat-CoV</i> | ENVVYLV | NAGH | FEDGR | AGELP | CAIIG | EKVI | AKIQ | NE | DVVV | FKNNT | PFPTN | VAVEL | FAKRS |
| <i>SARS-CoV</i> | ENVAYNV | VVKNKGF | HFDGH | AGEAP | VSIINN | NAVY | TKVD | GIDV | EI | FENK | TTLP | NVAF | ELWAKR |
| <i>229E</i> | ENIAFN | VVKN | KGSF | VGAD | GELP | VAIS | GDKV | FVRD | GNTD | NLVF | VNKT | SLPTN | VAFEL |
| <i>Bat-CoV-1a</i> | ENVAFNV | VVKH | G | SFV | GKDL | PVAIV | SDK | V | FVRD | GVDN | VIF | TNKT | TLP |
| <i>BtCoV512</i> | ENIAYN | VVVK | KGSF | VGE | GELP | VAVN | DKM | V | RDG | VSDN | V | V | N |
| <i>BtMr-AlphaCoV</i> | ENIAFN | VVKK | G | FV | GAD | GELP | VAVN | DR | M | V | R | D | G |
| <i>BtNv-AlphaCoV</i> | ENIAYN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>BtRf-AlphaCoV</i> | ENIAYN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>CDPHE15</i> | ENIAFN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>FCoV</i> | ENVAFNV | VVKG | A | F | T | G | L | K | D | L | P | T | A |
| <i>Ferret-CoV</i> | ENIAFN | VVKG | A | F | T | G | L | S | G | D | L | P | T |
| <i>HKU10</i> | ENIAYN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>HKU2</i> | ENIAYN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>HKU8</i> | ENVAFNV | VVKH | G | S | F | I | G | V | D | G | E | L | P |
| <i>LuchengRn-CoV</i> | ENLSYN | LLK | K | G | T | F | V | N | P | G | E | L | P |
| <i>Mink-CoV</i> | ENVAYN | VVKK | G | V | Y | T | G | L | T | G | D | L | P |
| <i>NL63</i> | ENIAFN | VVKK | G | C | F | T | G | V | D | G | E | L | P |
| <i>NL63-related</i> | ENIAFN | VVKK | G | C | F | V | G | E | G | E | L | P | V |
| <i>Porcine-EDV</i> | ENIAFN | VVKK | G | SF | V | G | S | F | V | G | S | F | V |
| <i>TGE</i> | ENVAFNV | VVKG | A | F | T | G | L | K | D | L | P | T | A |



| | 7880 | 7890 | 7900 | 7910 | 7920 | 7930 | 7940 | 7950 | 7960 | 7970 | 7980 | 7990 | 800 |
|----------------------|---------------------------------|---|-----------------------|---|-------------------------|--------------------------------|-------|-------|-------|-------|-------|-------|--------------------|
| <i>Bat-BCoV</i> | HIDQFCNADNAVLYSDYPIK | ----RLQGSKGPEHCSINGVIVNSTPDGG | ---- | EKPAINCTFYFYKRENGQLVNVG | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | NSYFTQSRVKSSFEPR |
| <i>Bovine-CoV</i> | ALEAFKRSNNGVYISTTKVK | ----SLSMIKGPPRAELNGVVVDKV | ----- | GDTDCVFFYFAVRKEGQDVIFSQFDSLVRSSNQSPQGNLGSN | ----- | EPGNVGGNDALATSTIFTQSRVISSFTCRT | ----- | ----- | ----- | ----- | ----- | ----- | ETYFTQSRNLQEFKPRS |
| <i>Covid-19</i> | QVDLFRNARNGVLI TEGSVK | ----GLQPSVGPKQASLNGVTLIG | ----- | EAVKTFQFNYYKKVDGVVQQLP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DTLFTQSRTLDDFEPRS |
| <i>GCCDC1</i> | AYSKFCQLNNAVYFSPQKPK | ----CVAIQGPPHASINGVVEIA | ----- | PEKGTQFWYAVRRNGEFVQLS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU1</i> | ALEAFRKARNGVFI STEKLS | ----RLSMIKGPPRADLNGVIVDKV | ----- | GELKVEFWFAMRKDGDVIFSRDLSLCSHYSWPQGNLGGNC | ----- | AGNVIGNDALTRFTIFTQSRVLSSEFPRS | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU14</i> | ALEAFKRCENGVYISTTKIK | ----SLQMIKGPRAELNGVVVDKV | ----- | GDTDVVFFYFAMRKDQDVIFSHIDSLGVSPYWSPQGNPGGNGKPGNVGGNDALAQVTIFTQSRVLSSEFCRS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU24</i> | ALEAFRNAQNGVFI STTKIK | ----SLSMIKGPPRAELNGLLVVDKV | ----- | GKEDVSFFYFAVRKEGQDVIFSQLTSLGVSSNWSWPQGNPGGYAKPENGAGNDALALGNLFTQSRQLETFEPRS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>HKU4</i> | SLERFMSMPNGVLISDRKIK | ----NYPCISGPKHAYFNAILRNI | ----- | DAKQPVIFLYLYKKNNEFVSFS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DTFYTCGRTVGDFTVLT |
| <i>HKU5</i> | SLERFMSLPNGILISDRKVK | ----NYPCIVSSNYAYFNGTLIRDNTGNSQSSDGEVQKPVTFYIYKKNNEFVQFT | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DTYFTLGRTVSDFTPVS |
| <i>HKU9</i> | AYSKFCQLKNAIYFSPKPK | ----CVCTRGPHTASINGVVVEA | ----- | PDRGTAFWYAMRKDGAFVQPT | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQSRTVDDFPRT |
| <i>Hedgehog-CoV</i> | SLEKFLTLPLNGILISDRKIK | ----NYPCVVGPDYAYFNATIRDS | ----- | ETIKQPVKFIYKKNLNGEFLQFS | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DSIYTOGRSCLDFEPT |
| <i>MERS-CoV</i> | SLEKFMSTPNAIFISDRKIK | ----KYPCMVGPDYAYFNATIRDS | ----- | DVVKQPVKFIYKKNNEFIDPT | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ECIYTOGRSCLDFLPLS |
| <i>MHV</i> | ALEAFKKCRNGVYINTTKIK | ----SLSMIKGPPRADLNGVVVEKV | ----- | GDSDFEWFAMRKDGDVIFSRDLSLCSHYSWPQGNPGGNC | ----- | VGDLSGNEALARGTIFTQSRLLSSFTPRS | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>OC43</i> | ALEAFKRSNNGVYISTTKVK | ----SLSMIRGPPRAELNGVVVDKV | ----- | GDTDCVFFYFAVRKEGQDVIFSQFDSLGVSSNQSPPQGNLGSNGKPGNVGGNDALSISTIFTQSRVLSSEFTCRT | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>Rat-CoV</i> | ALEAFKKCRNGVYINTTKIK | ----NLSMIKGPRAELNGVVVEKV | ----- | GDSDFEWFAMRSDGDVIFSRDLSLCSHYSWPQGNPVGNR | ----- | VGDLSGNEALARGTIFTQSRFLSSFPARS | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| <i>SARS-CoV</i> | QVDLFRNARNGVLI TEGSVK | ----GLTPSKGPAOASVNGVTLIG | ----- | ESVKTQFNYYKVDGI IOQLP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ETYFTQSRDLEDFKPRS |
| <i>229E</i> | SYERFTLSTNAVLF SATAVKTGGKSLPAIK | ----LNFGLMNGNAIATVKSE | ---D--- | GNIKINWVYVRKDGKHVDHY | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRNLQDFLPRS |
| <i>Bat-CoV-1A</i> | SFERFSLCRNGVLISITAVK | ----KLSAIK | ----LNYGYLNGFPITSH | ----- | DNKPVTWYIYVRKDGVFVDQC | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGIFTQGRNVSI FEPRS |
| <i>BtCoV512</i> | AFERFTVTKNAVLI SLTAVK | ----KLTAIK | ----LTYGYLNGVPVFTH | ----- | EDKPF TWYIYTRKDGAFVEYP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRVLSDFQPRS |
| <i>BtMr-AlphaCoV</i> | SFERFTMAKDAVLYSTTCIK | ----KLTCTIK | ----VNFGYLNGNAVSTTKEV | ---VGGETREKNVTWYIYTRKDGAFVDYR | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRNANDFVARS |
| <i>BtNv-AlphaCoV</i> | SLERFTLANNAVLF SFRQPIK | ----KLTGFK | ----INYGFLNGVPVSTT | ----- | EGKPVVWYFYVRSNGVNVVYV | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRITSTFLPRS |
| <i>BtRf-AlphaCoV</i> | SFERFTVAKNGVLISNVAIK | ----KLVGMK | ----LSYGFLNGVPVSTC | ----- | ENKPVVWYIYVRKDGQFVDQF | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRNVSEFLPRS |
| <i>CDPHE15</i> | SFERFTLDPDAVLISL TAVK | ----KLTPIK | ----ISYGYLNGVAVSQH | ----- | EKKPLTWYIYTRKGGKFDDYP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | EGFYTOGRTSADFKPRS |
| <i>FCoV</i> | SFERFTTTKDAVLISNNAVK | ----GLSAIK | ----LQYGFNLDPVSTV | ----- | GNKPVTWYIYVRKNGEYVEQI | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DSYTHGRTFETFKPRS |
| <i>Ferret-CoV</i> | SYERFTMCKDGVLI SNAIK | ----GLSPIT | ----LNFGYLNDLPVSTV | ----- | GNKPVKWIYVVRKNGQNTYVEQL | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGFYSQGRTFSTFKPRS |
| <i>HKU10</i> | SFERFTLTRNAVLI SNAIK | ----KLVGMK | ----IAYGLLNGVPVSVK | ----- | ENKPVVWYIYVRKDGQFVDQY | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRNIAEFLPRS |
| <i>HKU2</i> | AFERFTLCKNGVLISNVAIK | ----KLRGIR | ----LNFYGLNGVAVSSITEG | ---E--- | TTKPVWYIYVRKDGSEFVEPV | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYYSQGRNASTFLPRS |
| <i>HKU8</i> | SFERFSMCRDGVLI SNAIK | ----KLSAIK | ----LNYGYLNGEVPVTT | ----- | EDKPF TWYIYVRKDGQFLDQC | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DSIFTQGRSAENFVPR |
| <i>LuchengRn-CoV</i> | SLERFISCDGVL FQTAQK | ----GKTAIH | ----LNFYGLNGVPVSTTDE | ---VDGEIVKVKVDLYVYVRKNGQFVDQF | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGFYSQGRVSTFKPRS |
| <i>Mink-CoV</i> | SYERFTTSKDGVLIS SNAIK | ----GLVPIA | ----LNFYGLNLPVSTV | ----- | GNKPVKWIYVVRKNGVYVEHI | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGFYSQGRTFDTFKARS |
| <i>NL63</i> | SYERFTLTTNAVLF STVVIK | ----NLTPIK | ----LNFGLMNGMPVSSIKGD | ---K--- | GVEKLVNWIYVVRKNGQFQDHY | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGFYTOGRNLSDFTPRS |
| <i>NL63-related</i> | SYERFTLTTNAVLF SNTAIN | ----KLTPIK | ----LNFGLMNGLPVSTTKND | ---K--- | GVDKPVNWIYVVRKNGQFLDHY | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGFYTOGRNLADFLPRS |
| <i>Porcine-EDV</i> | SLERFSMTQNAVLM SLTAVK | ----KLTGIK | ----LTYGYLNGVPVNTH | ----- | EDKPF TWYIYTRKNGKFEDYP | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DGYFTQGRTTADFSPRS |
| <i>TGE</i> | SFERFTTTRDAVLIS NNAVK | ----GLSAIK | ----LOYGLLNDLPVSTV | ----- | GNKPVTWYIYVRKNGEYVEQI | ----- | ----- | ----- | ----- | ----- | ----- | ----- | DSYFTQGRTFETFKPRS |



8010 8020 8030 8040 8050 8060 8070 8080 8090 8100 8110 8120

Bat-BCoV TMERDFLELDMHGFIQRYNLEKYAFEHIVYGDVFSHQIIGGLHLLIGLTKRCNESTIDIEEFLT-MDSTIHNYFVTDQNTGSSKAVCSVIDLLDDDFVEI IKSQDLTVVSKVVKVFI DFRDFDFMLWC

Bovine-CoV DMEKDFIALDQDLFIQYKLEGYAFEHIVYGNFNQKIIGGLHLLIGLYRRQOTSNLVIQEFVS-YDSSIHSYFITDEKSGGSKSVCTVIDILLDDDFVALVKSLNLCVSKVNVNVDFKDFQFMLWC

Covid-19 QMEIDFLELAMDEFIERYKLEGYAFEHIVYGDVFSHSQLGGLHLLIGLAKRFKESPFLEDFIP-MDSTVKNYFITDAQTGSSKVCVSVIDLDDDFVEI IKSQDLTVVSKVVKVITIDYTEISFMLWC

GCCDC1 EMETDFLNLSQQDFLVKYDLEGYGLEHIAYGQFE-SVIGGLHLLIGLVLRKKVSDIRLESVLG-ND-TVTSYAVVDKPTAANKQVCSVFDVLLDDDFVALLKEQDRTVVSKVVKVQVTLDFKVRFLWC

HKU1 DLERDFIDMDDNLFIAKYGLEDYAFDHIVYGSFNHVKVIGGLHLLIGLFRKKKSNLLIQEFLQ-YDSSIHSYFITDQECGSSKSVCTVIDLLDDDFVSVKSLNLCVSKVNVNVDFKDFQFMLWC

HKU14 DMEKDFIALDEEMFIQYKLEGYAFDHIVYGSFNQKIIGGLHLLIGLFRRHQKSNLVVQEFVS-YDSSIHSYFITDDKSGGSKSVCTVVDILLDDDFVALVKSLNLCVSKVNVNVDFKDFQFMLWC

HKU24 EMERDFVQLEDEVFIQYKLEGYAFEHIVYGSFNQKIIGGLHLLIGLYRRQOTSLEIQEFIE-YDSSIHSYFITDQKSGGSKSVCTVIDLLDDDFVALVKSLDLNLCVSKVNVNVDFKDFQFMLWC

HKU4 PMEEDFLVLDSDVFIKYGLEDYAFEHVYGDVFSHTTLGGLHLLIGLYKMKREGHILMEEMLK-DRATVHNYFITDSNTASYKAVCSVIDLRLDDDFVTI IKEMDLVSVKVKVPI DLTMI EFMLWC

HKU5 EMKDFLALDSDVFIKYGLEDYAFEHVYGDVFSRTTLGGLHLLIGLYKKHQEGHI MEEMLK-ERATVHNYFITDSNTASYKAVCSVIDLKLDDDFVDI IKAMDLSVSVKVKVPI DLTMI EFMLWC

HKU9 QLEIDFLDLEQSCFLDKYDLHDLGLEHIVYQFD-GTIGGLHLLIGAVRRKRTAHLVMETVLG-TD-TVTSYAVIDQPTASSKQVCSVVDI ILLDDFIALI KAQDRSVSVKVKVQCCLDFKVRFLWC

Hedgehog-CoV QMEKDFLSMESNVFIKYNLEDYAFEHVYGDVFSHTTLGGLHLLIGLYKKSLEGHI MEEMLK-ESATIHNYFITETNTASFKAVCSVIDLTLDDDFVQLLKSDDLGVSVKVKVPI DLTMI EFMLWC

MERS-CoV DMEKDFLSFSDSDVFIKYGLENYAFEHVYGDVFSHTTLGGLHLLIGLYKKQOEGHI MEEMLK-GSSTIHNYFITETNTAFAKAVCSVIDLKLDDDFVILKSLDLGVSVKVKVPI DLTMI EFMLWC

MHV EMKDFMDLDDVFIKYSLQDYAFEHVYGSFNQKIIGGLHLLIGLARRQKSNLVQEFVT-YDSSIHSYFITDENSGGSKSVCTVIDLLDDDFVDIVKSLNLCVSKVNVNVDFKDFQFMLWC

OC43 DMEKDFIALDQVFIQYKLEGYAFEHIVYGNFNQKIIGGLHLLIGLYRRQOTSNLVQEFVS-YDSSIHSYFITDEKSGGSKSVCTVIDILLDDDFVALVKSLNLCVSKVNVNVDFKDFQFMLWC

Rat-CoV EMKDFMDLDEDVFTKYSLQDYAFEHVYGSFNQKIIGGLHLLIGLARRQRKSNLVQEFVS-YDSSIHSYFITDENSGGSKSVCTVIDLLDDDFVDILKSLDLNLCVSKVNVNVDFKDFQFMLWC

SARS-CoV QMETDFLELAMDEFIORYKLEGYAFEHIVYGDVFSHQIIGGLHLLIGLAKRSODSPLKLEDFIP-MDSTVKNYFITDAQTGSSKVCVSVIDLDDDFVEI IKSQDLTVVSKVVKVITIDYAEISFMLWC

229E TMEEDFLNMDIGVFIQYKLEDFNFEHVYGDVSKTTLGGLHLLISQVRLSKMGILKAEFVAASDITLKCCTVTVYLNDFSSKTVCTYMDLLDDDFVSLKSLDLTVVSKVHEVI IDNKPWRWMLWC

Bat-CoV-1A EMESDFLNLDMLGFIKYGLEDYAFEHIVFDVSKNTLGGHLLISQVRLSKMGVLKVEDFVSSADSTLKSCTVTVYVNDPSSKMCVCTYMDILLDDDFVNLKSLDLVSVKVKVHEVIDCKVYRWMLWC

BtCoV512 NMEEDFLNMDMGLFISKYGLEDYGFHVVFVGDVSKTTLGGLHLLISQIRLSKIGVLKVEDFVSSSDSTLKSCTVTVYVNDPSSKMCVCTYMDILLDDDFVNLKSLDLVSVKVKVHEVIDCKVYRWMLWC

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Ferret-CoV KMEEDFLAMDTTTLFIQYKLEDYGFHVVFVGDVSKTTLVGGMHLLISQIRLANMGLFSAQDFMMNSDSTLKSCTVTVYVNDPSSKVCVCTYMDILLDDDFVTI IKSQDLNLCVSKVNVNVDFKDFQFMLWC

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HKU8 QMETDFLELDMLGFIKYGLENFAFEHIVYGDVSKTTLGGLHLLISQVRLSKMGILKVEEFVHTGDSLRCAVTVYVNDPSSKMCVCTYMDILLDDDFVTLKSLDLVSVKVKVHEVIDCKVYRWMLWC

LuchengRn-CoV TMESDFLELDTDLFIKYGLEDYGFHVYGDVSKTTLGGLHLLISQIRLARIGYKIDDFGGNSDSTLKSCTVTVYVNDPSSKVCVCTYMDILLDDDFVTLKSLDLVSVKVKVHEVIDGKPRWMLWC

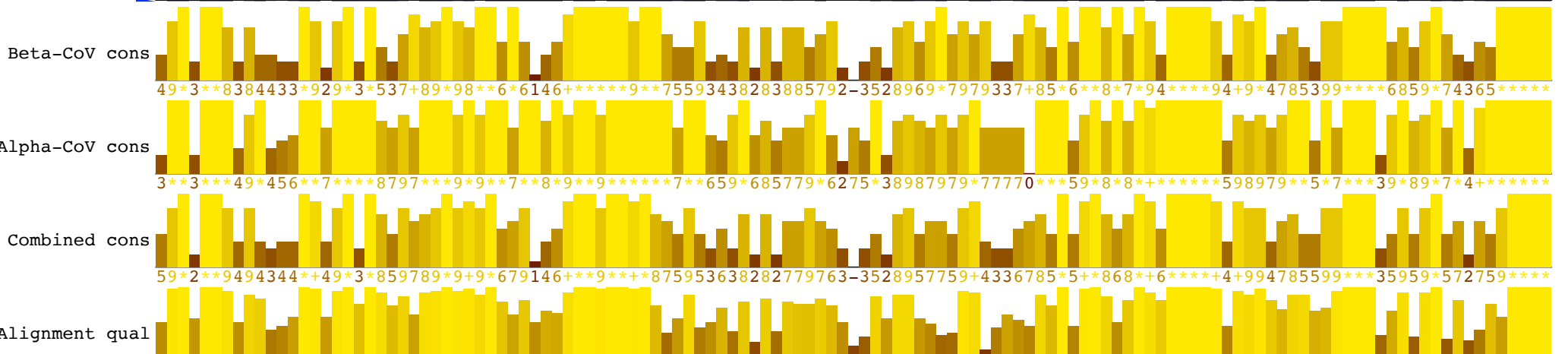
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NL63 DMEYDFLNMDMGVFIKYGLEDNFEHVYGDVSKTTLGGLHLLISQVRLSKMGVLKADDFVTASDITLRCCTVTVYLNELSSKVCVCTYMDLLDDDFVTI IKSQDLNLCVSKVNVNVDFKDFQFMLWC

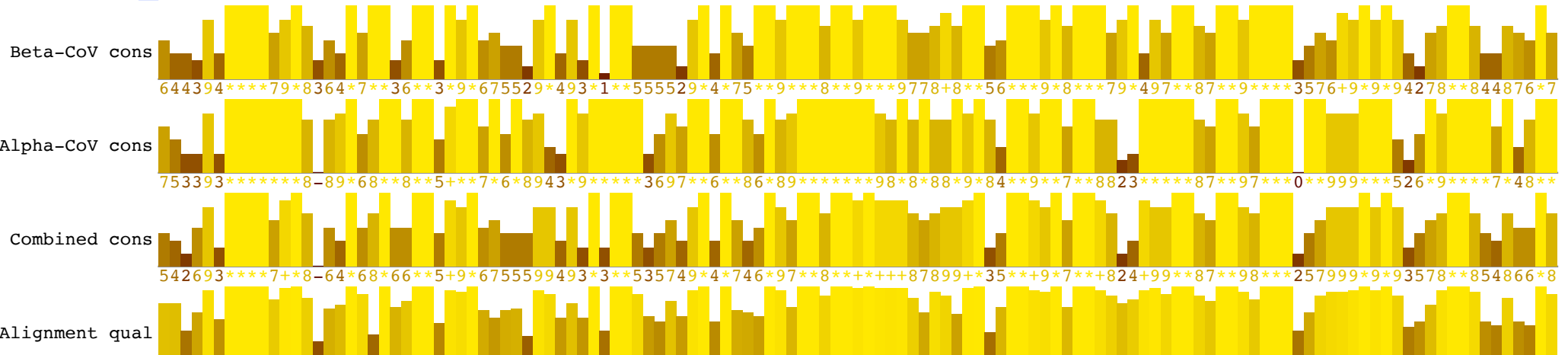
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Porcine-EDV DMEKDFLSMDMGLFINKYGLEDYGFHVYGDVSKTTLGGLHLLISQVRLAKMGLKIDEFVSSSDSTLKSCTVTVYVNDPSSKVCVCTYMDILLDDDFVTLKSLDLVSVKVKVHEVIDCKMWRWMLWC

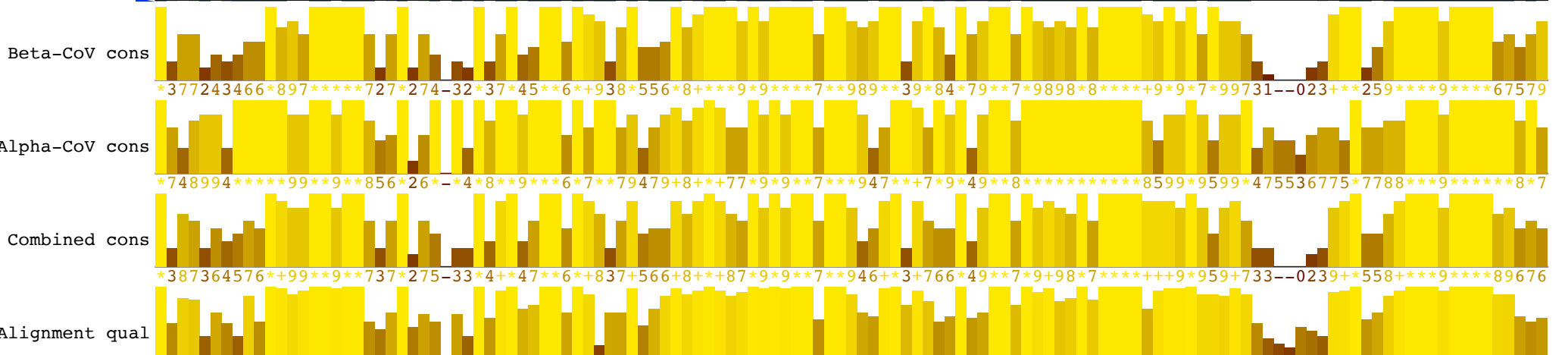
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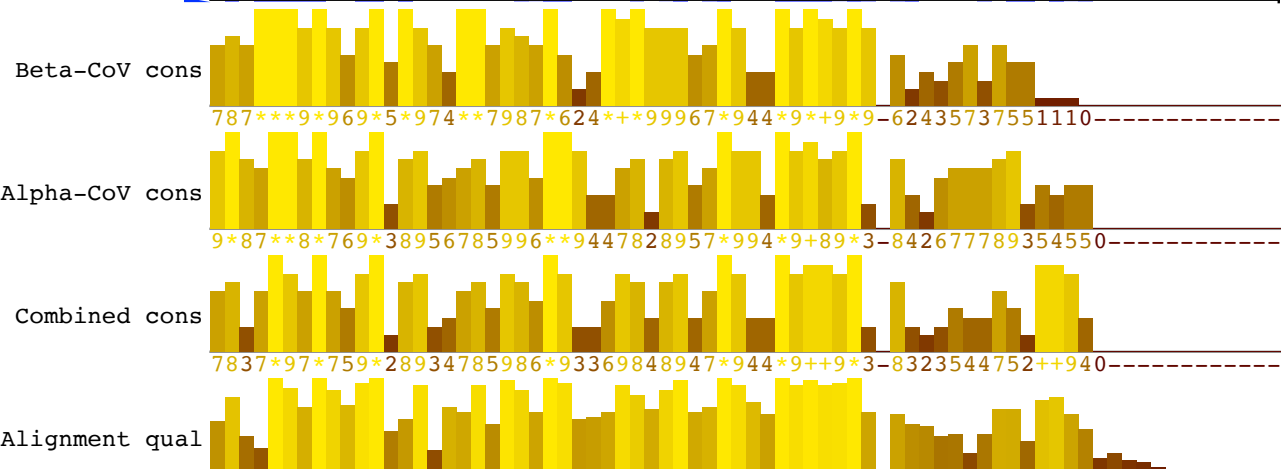
| | 8130 | 8140 | 8150 | 8160 | 8170 | 8180 | 8190 | 8200 | 8210 | 8220 | 8230 | 8240 | 8250 |
|----------------------|-------------|------------|-------------|------------|-------------|------------|-------------|-------------|------------|-----------|------------|------------|------------|
| <i>Bat-BCoV</i> | KDGVVQTFYPR | LQSSSEWQPG | QSMPLRYKIQT | MCMEKCELLN | YNGQPPLKPN | GILMNVAKYT | QLCQYLNKTTI | AVPAKMRVIHF | GAGSEKGIAP | GSTVLKQWL | PKDAILVDND | LNDLFASDAD | VTTIIGN |
| <i>Bovine-CoV</i> | NDEKVMTFYPR | LQAASDQWKP | GYSMPLYKYL | NSPMERVSLW | NYGKPVTLPT | GCMNVAKYTQ | LCQYLNTTTL | LAVPNMRVLH | LGAGSEKGV | APGSAVLRQ | WLPAGTILV | DNDLYPFV | SDSVATYFGD |
| <i>Covid-19</i> | KDGHVETFYPK | LQSSQAWQPG | VAMPNLYKM | QRMALLEKCD | LQNYGDSATL | PKGIMMNVAK | YTLQCYLNTL | TFLAVPYNMR | VIHFAGSD | KGVAPGTA | VLRQWLP | TGTLVDSD | LNDLFVSDAD |
| <i>GCCDC1</i> | KDGQIATFYPR | LQSKQDQWKP | GYSMPLYKVN | AVLEPCLLH | NYGQPARLPY | GTLMNVAKYT | QLCQYLNCT | LSVPAKMRV | MHFGAGSD | KGVCPGTS | VLKQWLP | TDALLVDN | DLDRCSVAD |
| <i>HKU1</i> | NDNKIMTFYPK | MQATNDQWKP | GYSMPLYKYL | NVPLERVSLW | NYGKPINLPT | GCMNVAKYTQ | LCQYLNTTTL | LAVPNMRVLH | LGAGSDEK | EVAPGSA | VLRQWLP | SGSILVDN | DLNPFVSD |
| <i>HKU14</i> | NEEKVMTFYPR | LQAASDQWKP | GYSMPLYKYL | TSPMERVSLW | NYGKPI TLPT | GCMNVAKYTQ | LCQYLNTTTL | LAVPNMRVLH | LGAGSEK | GVAPGSA | VLRQWLP | PAGTILID | NNDLYPFV |
| <i>HKU24</i> | NSDKVMTFYPR | LQAASDQWKP | GYTMPVLYK | YLNSSMERV | DLWNYGKVI | PLPTGCMNV | AKYTQLCQY | LNTTTLAV | PANMRVLH | LGAGSDK | GVAPGSA | VLRQWLP | PAGTILID |
| <i>HKU4</i> | RDGKVQTFYPR | LQATNDQWKP | GLTMSL | FKVQMNLEP | CLLANYKQ | SIPMPNGV | MNVAKYMQ | LCQYLNT | CTLAVPA | NMRVIHF | GAGCEK | GVAPGTS | VLRQWLP |
| <i>HKU5</i> | KDGQVQTFYPR | LQAINDQWKP | GLAMP | SLFKVQ | NAVLEPC | LLHNYKQ | SIPMPQ | GVMNIAK | YMQLAQ | YLNTCTI | AVPANMR | VMHFG | AGSDKGV |
| <i>HKU9</i> | KGGKISTFYPR | LQAKQDQWKP | GYSMPLYK | VQNAVLEP | CLLHNYG | QARLPSG | TLMNVAKYT | QLCQYLN | CTSLAVP | AKMRV | MHFGAG | SDKGVCP | GTAVL |
| <i>Hedgehog-CoV</i> | KEGQVQTFYPR | LQASNDQWKP | GLAMP | SLFKVQ | NVLEPC | LVNYGQ | SMSMPR | GVHMI | AKYMQ | LAQYL | NTCTI | AVPANMR | VMHFG |
| <i>MERS-CoV</i> | KDGQVQTFYPR | LQASADQWKP | GHAMP | SLFKVQ | NVNLER | CELANYKQ | SIPMPR | GVHMI | AKYMQ | LCQYL | NTCTL | AVPANMR | VIHF |
| <i>MHV</i> | NEEKVMTFYPR | LQAADQWKP | GYVMPVLY | KYLESPL | ERNLWNYG | KPI TLPT | GCMNVAKYT | QLCQYL | STTTL | LAVPAN | MRVLH | LGAGSD | KGVAPG |
| <i>OC43</i> | NDEKVMTFYPR | LQAASDQWKP | GYSMPLYKYL | NSPMERVSLW | NYGKPVTLPT | GCMNVAKYTQ | LCQYLNTTTL | LAVPNMRVLH | LGAGSEK | GVAPGSA | VLRQWLP | PAGTILV | DNDLYPFV |
| <i>Rat-CoV</i> | NEEKVMTFYPR | LQAADQWKP | GYVMPVLY | KYLESPL | ERNLWNYG | KPI TLPT | GCLMNVAKYT | QLCQYL | NTTTL | AVPANMR | VLH | LGAGSD | KGVAPG |
| <i>SARS-CoV</i> | KDGHVETFYPK | LQASQAWQPG | VAMPNLYKM | QRMALLEKCD | LQNYGDSATL | PKGIMMNVAK | YTLQCYLNTL | TFLAVPYNMR | VIHFAGSD | KGVAPGTA | VLRQWLP | TGTLVDSD | LNDLFVSDAD |
| <i>229E</i> | KDNAVATFYPR | LQSQS-AE | WCKGYSM | PGIYKTR | QRCLEPC | NLYNYG | AGLKLPSG | IMFN | VVYKTQ | LCQYFN | STTLC | VPHNMR | VLH |
| <i>Bat-CoV-1A</i> | KDYKVQTFYPR | LQSQS-AE | WCKGYSM | PVLYKQ | RMCLEPC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYLNT | TMCI | PHSMR | VLH |
| <i>BtCoV512</i> | KDHKVQTFYPR | LQSQS-AE | WCKGYSM | PIYKIQR | MCLEPC | NLYNYG | SGLKL | PDGIM | FNVVKYTQ | LCQYLNT | TM | CVPH | MRVLH |
| <i>BtMr-AlphaCoV</i> | KDAHVETFYPR | LQSQS-SE | WCKGYSM | PVLYKIQR | MCLDTC | NLYNYG | AGLKL | PDGIM | FN | TKYTQ | LCQYL | NTTM | CVPH |
| <i>BtNv-AlphaCoV</i> | KDNKVQTFYPR | LQSQS-AE | WCKGYSM | PVLYKIQR | MCLDTC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>BtRf-AlphaCoV</i> | KDHKVQTFYPR | LQSQS-AE | WCKGYSM | PIYKIQR | MCLEPC | NLYNYG | TGLKL | PDGIM | FNVVKYTQ | LCQYL | NTSM | CVPH | MRVLH |
| <i>CDPHE15</i> | KDHKVQTFYPR | LQSQS-AE | WCKGYSM | PVLYKIQR | MCLEPC | NLYNYG | AGLKL | PDGIM | FNVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>FCoV</i> | ENSQIKTFYPR | LQSQS-AE | WNPGYS | MPTLYKIQR | MCLERC | NLYNYG | AQVRL | PDGIT | TNVVKYTQ | LCQYL | NTT | VCPH | KMRVLH |
| <i>Ferret-CoV</i> | ENASIKTFYPR | LQSQS-AE | WKPYSMP | NLYKIQR | MCLERC | NLYNYG | ASLQL | PDGIT | TNVIKYTQ | LCQYL | NTSM | CVPH | KMRVLH |
| <i>HKU10</i> | KGHKVQTFYPR | LQSQS-AE | WCKGYSM | PIYKIQR | MCLERC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>HKU2</i> | KDSKVATFYPR | LQSQS-AE | WCKGYSM | PVLYKIQR | MCLDTC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>HKU8</i> | KDHKVQTFYPR | LQSQS-AE | WCKGYSM | PIYKIQR | MCLEPC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>LuchengRn-CoV</i> | KDNKVSTFYPR | LQSQS-SE | WCKGYSM | PVLYKIQR | MCLERC | NLYNYG | ASIKLP | DGIMF | NVVKYTQ | LCQYL | NTSM | CVPH | KMRVLH |
| <i>Mink-CoV</i> | ENATIKTFYPR | LQSQS-AE | WKPYSMP | NLYKIQR | MCLERC | NLYNYG | ASLQL | PDGIT | TNVIKYTQ | LCQYL | NTS | ICVPH | KMRVLH |
| <i>NL63</i> | KDNHLSTFYPR | LQSQS-AE | WCKGY | AMPQIYK | LQRCLEPC | NLYNYG | AGLKLPSG | IMLN | VVYKTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>NL63-related</i> | KDNHLATFYPR | LQSQS-AD | WCKGYSM | PQIYK | LQRCLEPC | NLYNYG | AGLKLPSG | IMLN | VVYKTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>Porcine-EDV</i> | KDHKLQTFYPR | LQSQS-SE | WCKGYSM | PIYKIQR | MCLERC | NLYNYG | AGVRL | PDGIT | TNVVKYTQ | LCQYL | NTTM | CVPH | MRVLH |
| <i>TGE</i> | ENSHIKTFYPR | LQSQS-AE | WNPGYS | MPTLYKIQR | MCLERC | NLYNYG | AOVKLP | DGIT | TNVVKYTQ | LCQYL | NTT | LCVPH | KMRVLH |



| | 8260 | 8270 | 8280 | 8290 | 8300 | 8310 | 8320 | 8330 | 8340 | 8350 | 8360 | 8370 | 8380 | | | | | | | | | | | | |
|----------------------|------|--------|------|--------|--------|---------|----------|----------|---------|-------|--------|--------|--------|---|-----|-----|---|---|---|---|---|---|---|---|---|
| <i>Bat-BCoV</i> | CVT | FHTETK | WDLV | SDMYD | CD | FKS | T | MGENYS | KD | SFF | P | YLC | GFI | | | | | | | | | | | | |
| <i>Bovine-CoV</i> | CIT | LPFDCQ | WDLI | ISDMYD | P | ITKNIG | -EYNVSKD | GFFTY | ICHM | IRD | KLALGG | SVAIKI | TEFSW | | | | | | | | | | | | |
| <i>Covid-19</i> | CAT | VHTANK | WDLI | ISDMYD | P | TKNVT | -KENDS | KEGFFTY | ICGFI | QOKL | ALGG | SVAIKI | TEHSW | | | | | | | | | | | | |
| <i>GCCDC1</i> | CEL | FSTNHK | WDLV | ISDMYD | ART | KQVN | -GDNIS | KEGFFTY | L | TGFI | KSKL | ALGG | SI | | | | | | | | | | | | |
| <i>HKU1</i> | CM | TLPF | DCHW | DLI | ISDMYD | PLTKNIG | -DYNVSKD | GFFTY | ICH | L | IRDKL | SLGG | SVAIKI | | | | | | | | | | | | |
| <i>HKU14</i> | CIT | LPFECQ | WDLI | ISDMYD | P | ITKNIG | -EYNVSKD | GFFTY | ICHM | IRD | KLALGG | SVAIKI | TEFSW | | | | | | | | | | | | |
| <i>HKU24</i> | CV | TLPF | DCQW | DLI | ISDMYD | P | ITKNIG | -EYNVSKD | GFFTY | ICH | L | IRDKL | ALGG | | | | | | | | | | | | |
| <i>HKU4</i> | CV | TVHV | GQ | VDLL | ISDMYD | P | CTKAVG | -EVNQT | KAL | FF | V | YLC | NFI | | | | | | | | | | | | |
| <i>HKU5</i> | CVT | VRV | GQ | VDLL | ISDMYD | P | STKVVG | -ETNEA | KAL | FF | V | YLC | NFI | | | | | | | | | | | | |
| <i>HKU9</i> | CET | FFSV | NKW | DFL | ISDMYD | ART | KNTS | -GDNTS | KEGFFTY | L | TGFI | KSKL | ALGG | | | | | | | | | | | | |
| <i>Hedgehog-CoV</i> | CAT | VRIG | Q | VDLV | ISDMYD | P | STKNVR | -ESN | SKAL | FF | T | YLC | NFI | | | | | | | | | | | | |
| <i>MERS-CoV</i> | CV | TVR | V | GQ | VDLV | ISDMYD | P | T | TKNVT | -GS | N | SKAL | FF | T | YLC | NFI | | | | | | | | | |
| <i>MHV</i> | CIT | LPF | DCQW | DLI | ISDMYD | PLTKNIG | -EYNVSKD | GFFTY | ICH | L | IRDKL | ALGG | SVAIKI | | | | | | | | | | | | |
| <i>OC43</i> | CIT | LPF | DCQW | DLI | ISDMYD | P | ITKNIG | -EYNVSKD | GFFTY | ICHM | IRD | KLALGG | SVAIKI | | | | | | | | | | | | |
| <i>Rat-CoV</i> | CIT | LPF | DCQW | DLI | ISDMYD | PLTKNIG | -EYNVSKD | GFFTY | ICH | L | IRDKL | ALGG | SVAIKI | | | | | | | | | | | | |
| <i>SARS-CoV</i> | CAT | VHTANK | WDLI | ISDMYD | P | R | TKHVT | -KENDS | KEGFFTY | ICGFI | QOKL | ALGG | SI | | | | | | | | | | | | |
| <i>229E</i> | CAT | V | YLED | K | F | D | L | I | S | D | M | Y | D | G | R | T | K | A | I | D | | | | | |
| <i>Bat-CoV-1A</i> | CT | T | L | Y | L | Q | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | I | K | Q | M | D |
| <i>BtCoV512</i> | CAS | M | Y | L | T | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | T | K | S | C | D | |
| <i>BtMr-AlphaCoV</i> | CNT | L | F | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | T | K | L | C | D | |
| <i>BtNv-AlphaCoV</i> | CST | L | Y | L | T | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | I | K | A | I | D | |
| <i>BtRf-AlphaCoV</i> | CST | V | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | V | K | Q | N | D | |
| <i>CDPHE15</i> | CT | T | L | Y | L | A | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | I | K | L | C | D |
| <i>FCoV</i> | CT | S | L | Y | L | E | D | K | F | D | L | V | I | S | D | L | Y | D | G | S | T | K | S | I | D |
| <i>Ferret-CoV</i> | CT | T | M | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | T | T | K | A | I | D |
| <i>HKU10</i> | CST | V | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | T | K | H | C | D | |
| <i>HKU2</i> | CT | H | V | Y | V | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | I | K | S | I | D |
| <i>HKU8</i> | CT | T | L | Y | L | Q | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | I | K | H | I | D |
| <i>LuchengRn-CoV</i> | CC | S | M | Y | L | D | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | T | K | Q | I | D |
| <i>Mink-CoV</i> | CT | S | M | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | S | T | N | K | S | I | D |
| <i>NL63</i> | CAT | V | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | R | I | K | F | C | D | |
| <i>NL63-related</i> | CAT | V | Y | L | E | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | T | K | S | C | D | |
| <i>Porcine-EDV</i> | CST | L | Y | L | S | D | K | F | D | L | V | I | S | D | M | Y | D | G | K | I | K | S | I | D | |
| <i>TGE</i> | CT | S | L | Y | L | E | D | K | F | D | L | V | I | S | D | L | Y | D | G | S | T | K | S | I | D |



| | 8390 | 8400 | 8410 | 8420 | 8430 | 8440 | 8450 |
|----------------------|---------------|--------------|-------------|-------------------|--------------|--------------------|----------------|
| <i>Bat-BCoV</i> | VSNYSLFDMSKFA | LKAKGTPVMSL | KEQINEMVLGL | VEKGRLLIRD | -TNSFVLTNDMM | VNC----- | ----- |
| <i>Bovine-CoV</i> | GGAYSLFDMAKFP | LKLAGTAVINLR | ADQINDMVYSL | LLEKGGKLLVRD | -TNKEVFGDSL | VNVI----- | ----- |
| <i>Covid-19</i> | LSSYSLFDMSKFP | LKLRGTAVMSL | KEQINDMILSL | LKSGRLIIRE | -NNRVVISSD | VLVNN----- | ----- |
| <i>GCCDC1</i> | LSSYSLYDLQRF | SLRAKGTPTVMT | LNESQLNELVL | NLLKAGRLLIRD | -VSDVALSGVV | ----- | ----- |
| <i>HKU1</i> | GGAYSLFDMTKF | SLKLAGTAVNLR | PDQNLNDLVSL | IERGKLLVRD | -TRKEIFVGD | SLVNTC----- | ----- |
| <i>HKU14</i> | GGAYSLFDMAKFP | LKLAGTAVINLR | ADQINDMVYSL | LLEKGGKLLIRD | -TNKEVFGDSL | VNVI----- | ----- |
| <i>HKU24</i> | GGYSLFDMTKFPL | LKLAGTAVNLR | ADQINDMVYSL | IEKGGKLLVRD | -TNKECFTGD | SLVNVSNLN----- | ----- |
| <i>HKU4</i> | LSTYSLFDLSRF | PLKLGTPVLQ | LKESQINELV | ISLLSQGKLLIRD | -NDTLNVST | DVLVNFKRRL----- | ----- |
| <i>HKU5</i> | LSTYSLFDLSRF | PLKLGTPVLQ | LKESQINELV | ISLLSQGKLLIRD | -NDTLNVST | DVLVNFYRKP | HKRSKC----- |
| <i>HKU9</i> | LSSYSLYDLQRF | PLRLKGTPTVMT | LNESQLNELVL | NIRAGRLIIRD | -AVDIGVRGV | VACSGV----- | ----- |
| <i>Hedgehog-CoV</i> | LSTYSLFDLSKF | CLKLGTPILQ | LKESQINELV | SVSLLSQGKLLIRD | -NDTLNVST | DVLVNVYKSN | PKRGNMYIC----- |
| <i>MERS-CoV</i> | LSTYSLFDLSKF | QLKLGTPVLQ | LKESQINELV | ISLLSQGKLLIRD | -NDTLNVST | DVLVNTYRKL | R----- |
| <i>MHV</i> | GGAYSLFDMSKFP | LKAAGTAVVSL | KPDQINDLVSL | IEKGGKLLVRD | -TRKEVFGD | SLVNVK----- | ----- |
| <i>OC43</i> | GGAYSLFDMAKFP | LKLAGTAVINLR | ADQINDMVYSL | LLEKGGKLLIRD | -TNKEVFGD | SLVNVVI----- | ----- |
| <i>Rat-CoV</i> | GGAYSLFDMSKFP | LKAAGTAVVSL | KPDQINDLVSL | IEKGRLLIRD | -TRKEVFGD | SLVNVK----- | ----- |
| <i>SARS-CoV</i> | LSSYSLFDMSKFP | LKLRGTAVMSL | KEQINDMIYSL | IEKGRLLIIRE | -NNRVVVSSD | ILVNN----- | ----- |
| <i>229E</i> | LSYNSVLDLSKFN | CKHKATVVVQ | LKDSINDMVL | SLVRSGLLVRG | -NGKCLFSN | NHLVSTK----- | ----- |
| <i>Bat-CoV-1A</i> | MSYNSVLDLAKF | QCRHKATVVV | IALKDNDISD | VILGLIKNGKLF | IRK-NGVVC | SYGNHLVSTK----- | ----- |
| <i>BtCoV512</i> | MSYNSVLDLSKFS | CKHKATVVVNL | KDSSVTDVL | GLLKNKGLLIRN | -NGVVC | GFSNHLVNSTK----- | ----- |
| <i>BtMr-AlphaCoV</i> | MSYNSVLDLSKFA | CKHKATVVVSL | KDGDINSMV | IGLVKSGKLLVRN | -NKL | CGFSNHLVSTK----- | ----- |
| <i>BtNv-AlphaCoV</i> | MSYNSVLDLTRF | ECKHKATVVVNL | KESDVNEV | VLGLVKSGLLIRN | -TG | VCGYAPPHLSHV----- | ----- |
| <i>BtRf-AlphaCoV</i> | MSYNSVLDLAKFN | CRHKATVIVS | LKDKDINDV | VLGLIRNGKLLIRN | -NGIYM | GFSNHLVSTK----- | ----- |
| <i>CDPHE15</i> | MSYNSVLDLSKFA | CKHKATVVVNL | KENAI | SDLVVS | LVRSGLLVRG | -SGPLVNL | SNHLVNTK----- |
| <i>FCoV</i> | LSHNSVLDTPKF | KRCNNALIVN | LKEKELNEM | VVGLLRKGGKLLIRN | -NGKLLN | FGNHLVNP----- | ----- |
| <i>Ferret-CoV</i> | LSYYSVFDLTKF | CKCFNNALV | VNLKESDIN | VMVKGLIKGGKLLVRN | -NGKLLN | FGNHLVNV----- | ----- |
| <i>HKU10</i> | MSYNSVLDLAKFN | CKHRATAVI | QLKDSINDM | VLGLIKRGKILVRM | -NGTYM | GFSNHLVSTKQR----- | ----- |
| <i>HKU2</i> | MSYNSVLDLSKFR | CKHKATVITL | KDKDITDM | VLGLIKNGKLLIRN | -SQKLLN | FSNHLVTTK----- | ----- |
| <i>HKU8</i> | MSYNSVLDLSKFE | CRHKATVVV | IALKDTDL | SEVIVGLIRNGKLLIRK | -NGSVC | GYGNHLVSTK----- | ----- |
| <i>LuchengRn-CoV</i> | LSYNSVLDVNF | RKCKATPVLS | LKDGSTPL | VLTLIKNGKLLIIRD | -TGVVV | SFSNHLVNLTK----- | ----- |
| <i>Mink-CoV</i> | LSYYSVFDLTKF | CKCFNNALV | VNLKDSIN | VMVKGLIKGGKLLVRN | -NGKLLN | FGNHLVNV----- | ----- |
| <i>NL63</i> | LSYNSVLDLSKFE | CKHKATVVV | TLKDSVND | MVLSLIKSGRLLLRN | -NGR | FGGFSNHLVSTK----- | ----- |
| <i>NL63-related</i> | LSYNSVLDLSKFE | CKHKATVVV | TLKDSVND | MVLSLIKSGRLLLRN | SSGR | FGGFSNHLVSTKQ----- | ----- |
| <i>Porcine-EDV</i> | MSYNSVLDLSKFN | CKHKATVVVNL | KDSSISD | VVGLLKNKGLLVRN | -NDAIC | GFSNHLVNVNK----- | ----- |
| <i>TGE</i> | LSHNSVLDTPKF | KRCNNALIVN | LKEKELNEM | VIGLIRKGGKLLIRN | -NGKLLN | FGNHFVNTP----- | ----- |



130 140 150 160 170 180 190 200 210 220 230 240 250

229E -----MFVLLVAY-----

NL63 -----RSAFALHTGY--DANQY--YIYVTNEIG-----LNASVTLKICKFSRNTTFDFLS--NASSSFDCIVNLLFT-E-----QLG--APLGITISGETVRLHLYNVTRTFYVPAAYKLT

HKU8 -----AFEIGVSSSA--GGEQY--SAYMAQON-----GKYLVLRLICKWONGTAAAP-T-LQSTSGKDCIVNVKVDNH--MFYHAAH--DIVGMSWSGDVAVRLYTQDTKTYIIPN--SWDR

Ferret-CoV -R-----DLAFAVY-----GYPY--TAIVVLNKL-FN--GOYGGLLFCFNGNSTIPAF-----NANC-STSTCVRSFRL-----CADESICHERILGLKWSGSSEVAYLAGEVYSYKLSN--HWYN

CDPHE15 -----VAQFGISST-LRRSLSPY--SIFYLNYGNG-----RR--HIIRICKWDTDKMLQDS--DATTGYDCIANVRINDV--VLEHGG--QIYGLSWSGNVVTLHMLKGRHITVPGAQYWDI

HKU10 -----PWSIGVSNSDLVARETW--SLYVSHGN-----NRGVMTRICKWPRVPGLAQEP-TPNTGGVNCVVDKQFP-F--TFQHEAN--EMVGITWSSDYVRIYGLQSTYRFYFPN--KWNK

BtRf-AlphaCoV -----GVELGISASDYEQNPQW--ALYMYQNNNATFN--DSKGVLYFRVCKYAGKYTPVGNP-D-KTVSKVCLIDKKS-F--KFADMKN--EVIGVTWSGNVYTFYGIYKSFRIYLPN--KWNF

LuchengRn-CoV -----PWKCNSYS--NGP-SN-KFNGIGVFDLASA-----QHSWH-----LFVYPSMPTNKT-----WIL

Mink-CoV -GVNNKYLLVSIH-----GSPY--SATVYHKNGE-M--ARYDSGRFCLCKGAINTTVAT-G-SGNCWGYDCKINSTFW---NCNNTGCGDLLYGLQWSNSELMAYLSGDIYRIKLYN--TWFN

Bat-CoV-1A -----EVAVGVGNSKS--NDSI--GIYFNHHN-----GNKSTILRVCRWHKYMPSTYTP-TITTTGGKDCVINTNLK-L--SFVDQGNHSDIFGLSWSGDRLTIYSLDGVKSYYIPIGIGELDV

BtMr-AlphaCoV -----DFAIGVSSSTS--YAEKW--GLYFWQKN-----NEGRAVFRICKWDASAQTNFAP-DRH-TARDCFVNKQIP-M--VFKHQGN--EIVGVSWSGSRVTLHTLDRVFSFIVEGAESWDY

BtNv-AlphaCoV -----AWSFGVGPSTT--IDGHY--GLYVWHSN-----SAGHMTVIRICRWYQDRDPIAQNSPHDTTSSDCILNVRQP-Y--VFTHAGF--QVIGVSWTGEAVTVYGKSKLYRLYVPGASLWNS

Porcine-EDV -----GFEIGISQE--PFDPSGY--QLYLHKATNG-----NTNAIARLRICQFPDNKTLGPTV-NDVTTGRNCLFNKAIPAY--M-RDGKD--IVVGITWDNDRVTVFAD-KIYHFYLYK--NDWSR

BtCoV512 -----GFTIGVSQY--NFD PSTY--QLYLHRDTNG-----NSNAFAYLRICKWPSKKWLQSTS-NMDTSGRFCLVNKKIPAA--F-TDHAN--MVVGITWDQDRVTFYTD-KVYHFYVFN-NRWSR

HKU2 -----KWF CPTNV--GRP-VG-TGVGIGVYAQTAQASYETGGSG-----AGGYT-----FSVSPKHVTNLT-----WSL

NL63-related -----ASAFGLGSSKF--DPNIY--QMYFGHRN-----QHNSTRVIRICKWPSVQVPTLPR-DPPVAPKDCLVDKQFQ-Y--QFAHKGH--KIYGVTFSGDRVRIHSTVGVHNFYVPGASNWDT

FCoV GNARGKPLLFHVH-----GEPV--SVIISAYRDD-VQORPLLKHLGVCITKNRH--INYEQF-TSNQWNSTCTGADRKIPF--SVIPTDNGTKIYGLEWNNDFVTAYISGRSYHLNINT--NWFN

TGE WNH-RORLNVVVN-----GYPY--SITVTTTRNF-----NSAEGALICICKGSPPTTTTTESS-LTCNWGSECRLNH-KFPICPSNSEANCGNMLYGLWFADDEVVAYLHGASYSIFEN--OWSG

OC43 -----NMALKGSVLLSR--LWFKPPF-----L--SDFINGIFAKVKNTKVI-----KDRVMYSEFP-----AITIGSTFVNTS-----YSV

MERS-CoV -----MYVYS--AGHAT-GT--TPQKLFVANYSQD-V--KQFANGFVVRIGAAANSTGTVI---ISP--STSATIRKIYP-----AFMLGSSVGNFSDG-----KMGR-F-----FNHTL

HKU1 -----DLSLKGTTYLST--LWYQKPF-----L--SDFNNGIFSRVKNTKLY-----VNKTLYSEFS-----TIVIGSVFINNS-----YTI

Covid-19 -----WFH---AIHVS-GTNGT--K--RFDNP-V--LPFNDGVYFASTE-----KSNIIIR-----GWIFGTTLD SKT-----QSL

Bovine-CoV -----NMALKGTLLLST--LWFKPPF-----L--SDFTNGIFAKVKNTKVI-----KDGVMYSEFP-----AITIGSTFVNTS-----YSV

HKU4 -----QYLYS--VSHAV-GHDGDPKAYISNYSLV--V--NDFDNGFVVRIGAAANSTGTIV---ISP--SVNTKIKKAYP-----AFILGSSLTNTSA-----GQPL-Y-----ANYSL

HKU5 -----QYLFS--DGHSA--PGRLNNLFVSNYSSQ-V--ESFDDGFVVRIGAAANKTGTTV---ISQ--STFKPIKKIYP-----AFLLGHSVGNYPSPN-----RTGR-Y-----LNHTL

HKU9 -----LYPVTTPANGAN--G--GF--IYNTS-I--IPVSAGLFVNTWMYRQP-----AS--SRAYCQEPF-----GVAFGDTFENDR-----IAI

SARS-CoV -----GFH--TIN--H--TFGNP-V--IPFKDGIYFAATE-----KSNVVR-----GWVFGSTMNKS-----QSV

HKU24 -----NLLLKGTQWLST--NWFLPPF-----L--SEFNDSGIFVKARNKSPV-----LNGITHSEFG-----TIVFGTSFVNTT-----YTI

Rat-CoV -----NMALMGTNTLSL--NWFEPF-----L--SEFNDSGIYAKVKNLKS-----LPIGSASYFP-----TIIIGSNFVNTS-----YTV

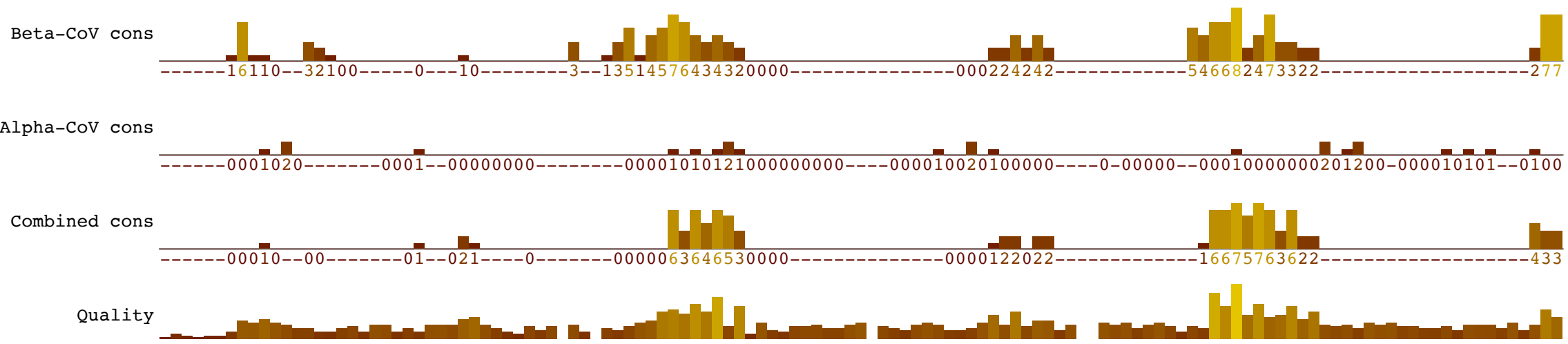
Bat-BCoV -----PWK--AFNAL-TTNER--KD--KRNF-E-R--HPFGEVFTIKHTQV-----SGPSTPP-----MYLFGTYFNSSS-----YTL

Hedgehog-CoV -----MYVYS--QSHKG-----RPFISNYSLV-T--NDFGNGIVIRIGSAANKTGSPV---ISNIASNFQIMKKLYP-----ALLFGSAVGKFPANN-----KTGA-Y-----FNHSL

GCCDC1 -----VYPVTPPMFNL-TYGNVT--PG--VYNTS-F--LPVFDGLLVHTYMNRF--H--LDN--PNRTCQEPF-----GVVFGTTFEQDR-----IAM

HKU14 -----NMALKGTLLLST--LWFKPPF-----L--SDFNNGIFAKVKNTKVI-----KNGVMYSEFP-----AITIGSTFVNTS-----YSV

MHV IGSLFGYTSYTVVIEPYNGVIMASVCOYTTICOLPYTDCKPNTNGNKLIGFWHTDVKPPICVLKRNFTLVNADAFYFHFYOHGGTFYAYYADKPSATTFLFSVYIGDILTTOYVLPFICNPTAGSTF



260 270 280 290 300 310 320 330 340 350 360 370 380

229E -----A-----LLHI--AGCQT-TNGTN-T--SHSVCNGCVGHSENVF-AVESGGYIPS-----NFSFNWFLLTNTSSVVDGTVRSFQPLLLNCLWSVSGSQF---TTGF

NL63 L-SVK-----CYFNYSVFSVFNATVT--VNVTT-HNGRV-V--NYTVCDDCNGYTDNIF-SVQDGRIPN----GFPFNWFLLTNGSTLVDGVSRLYQPLRLTCLWPVPLKMS---STGF

HKU8 V-SIR-----CPDKFSCSSQIVTKAIT--VNVTTFANGTI-D--KYAICDNCGYPAHIF-PVSEGLIPA----DFNFSNWFLLTNSSTIVDGRIVSEQPVLLMCLWAVPGLMS---TNSF

Ferret-CoV NVTIKTQTN-----ANQIYWFWFNPVRDLSYYNVNKTV--DSTI-VVSNCT--SDCSGYAANIF-AVETGGFIPS-----SFSFNWFLLTNSSTIVSGKFVSSQPLRLTCLWPVPSFGD---ETSI

CDPHE15 I-RFS-----CGHKDSCGHQVYSTNVFNVTVLNG---FI-T--NYQVLPDSGEFSDNLF-TVGDDGSIIP-----SFGFNWFLVLSNSSIIISGTVVSNQPLRLTCLWPIPSSTG---ALAT

HKU10 V-NVN-----CAHKSSCQVYPVKDSVT--WVNTTADGRV-K--DYTICGSCNGFPQHVF-PVSPGGLIPP-----DFSFDGWYVLTNSSTMVQGFVVASQPLKLLCLWPVPALDS---SASV

BtRf-AlphaCoV V-AVK-----CLVKETCAFFAAHKMVT--LNITTNQGLI-K--NYSVKDCNGFPQHVF-PVLDGGKIPG-----DFSFDNWFLLTNSSTIVNGKIVDIQPLKLLCLWPVPALVA---NDNK

LuchengRn-CoV SWADTH-----T-----SFEHGSVISYVQICKYPSNVVTDI--TNGNGCHTNMAG-PGATTCDVILSS-----PLECVLNRTY-----

Mink-CoV NATISNTFA---SNGTTSNSWVFNPNVYNTLYYRVNKT---DNTV-VVQNT--NNCADIYVNNIF-STESGGIIP-----GFSFNWFLVLTNDSTITDGRFLTRQPLLVNCLWPVPSFSE---TSQN

Bat-CoV-1A V-SFR-----CVYKETCAHQVITKPIT--AIVNTTADGLI-S--GYSVCDDCDGFPKYVF-AVTEGGEVPP-----NFRLDNWFYLTNSSTPISGMFTSVQPFNLSCVWTVPVLTN---NSLP

BtMr-AlphaCoV A-TLR-----CANGYACAHQVYVNPVT--VIVTTVAAG-I-Q--KYTLCDNCTGFPQHVF-ATMENGEIIP-----SFNFANWFYLTNSSSPVSSRVVGLQPLLLTCLWPIPALG---TATD

BtNv-AlphaCoV V-AFT-----CSKDDSCGHQIITKPIT--VNATDDKGI-T--SYTVCDRCDGFPHHVF-AVQEGGKIPG-----SFDFTNWFYLTNTSSPFDGRFVSNQPLQIQCLWPIPALTS---TTGI

Porcine-EDV V-ATR-----CYNRRSCAMQYVYTPTYMLNVTSAAGEDGI-Y--YEPCTANCTGYAANVF-ATDSNGHIPE-----GFSFNWFLLSNDSTLLHGKVVSNQPLLVNCLLAIPKIYG---LGQF

BtCoV512 V-VSW-----CSAADSCAMQYINSTIYYNLNVTTTPGGGI-T--YSVCTKHCTGLADNVF-STDQGGHIP-----IFPYNNWFLLTNTSTLVQGVTRVFPFLVNLVALPKLQ---LTTT

HKU2 WVHRP-----WGA-NANVTVRLCRWQKFSF-----NETAHFQAPAG-P-----SS-----AFECVLNGSF-----

NL63-related V-AIA-----CDNPTSCYHSVVTQLAT--VRVQTDKGLI-S--SFEPCEQCEGFAENVF-AVEASGKIPS-----DFSFNWFLLTNSSSVVDGKVRSLQPLKVLCLRAVPSLLS---TKEV

FCoV NVTLLYSRSSTAT--WEYSAAYAYQGVSNFTYYKLNNT---NGLK-TYELCEDYEHCTGYATNVF-APTSGGYIPD-----GFSFNWFLLTNSSTFVSGRFVTNQPLLINCLWPVPSFGV---AAQE

TGE TVTFGDMRATTLEVAGTLVLDLWVFNVPYDVSYYRVNKK---NGTT-VVSNCT--DOCASYVANVF-TTOPGGFIPS-----DFSFNWFLLTNSSTLVSGKLVTKOPLLINCLWPVPSFEE---AAST

OC43 VVQPRTIN-----ST-----QD-----GDNKLQGLLEV-SVCQYNMCEYPQT-----I CHPN-LG-NHRKELWHLDTG-----VVSCLYKRN-----

MERS-CoV VLLPDG-C---GTLRAFICYI-----LEPRSG-----NHCPAGNSYTSFATYHTPATDCSDGNYNRNASLNSFKKEYFN-----LRNCTFMITY-----

HKU1 VVQPHN-----GVLEI-TACQYTMCEYPHT-----ICKSK--GSSRNESWHFDKS-----EPLCLFKKN-----

Covid-19 LIVNNA-----TNVVIKV-CEFQFCNDPF---LGV-----YYHKNNKS--WMESEFRVYSS-----ANNCTFEYVS-----

Bovine-CoV VVQPHTTI-----LGNKLQGFLEI-SVCQYTMCEYPNT-----ICNPN-LG-NQRVELWHWDTG-----VVSCLYKRN-----

HKU4 TIIPDG-C---GTVLHAFICYI-----LKPRTV-----NRCPSGTGYVSYFIYETVHNDQS-TINRNASLNSFKSFFD-----LVNCTFFNSW-----

HKU5 VILPDG-C---GTILHAFYCV-----LHPRTQ-----QNCAGETNFKSLSLWDTPASDCVSGSYNQEATLGAFKVFYD-----LINCTFRYNY-----

HKU9 LIMAPDNL---GSW---SA-----VAPRNQTNIIYLLVCSNATLCINPG---FNR-----WGPAGSFI---APDALVDH-----SNSCF---VN-----

SARS-CoV IIINNS-----TNVVIRA-CNFELCDNPF---FAV-----SKPMGT-----QHTMIFDN-----AFNCTFEYIS-----

HKU24 VIEPSTQI-----VNGKLIGTLSA-SVCQYTMCEYPNT-----ACNPV-LG-NGRPSLWHASIG-----IVPLYQRNF-----

Rat-CoV VLEPIN-----GIIMA-SICQYITICQLPHT-----YCKPN-TGGNTLIGFWHTDLR-----SPVCILTRNF-----

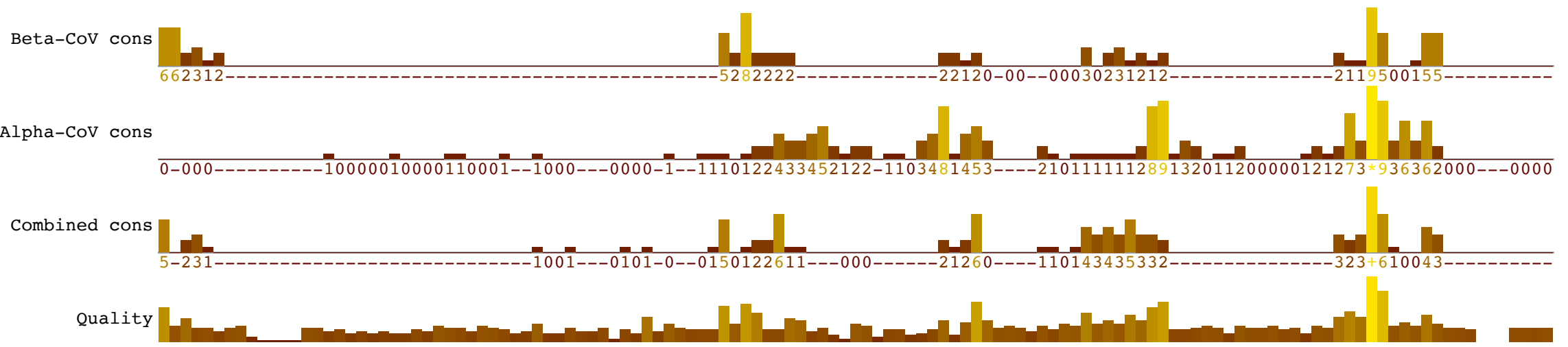
Bat-BCoV AISLDG-----LYRRIEV-CNFQVCQNPV---MYV-----AKVSNPAQGNPLIYSQRAYTD-----YNSCVS-QTS-----

Hedgehog-CoV VILPEK-C---GTVITALYCV-----LEPKND-----TNCTGSSGYVSYVLFENFSCDATT---DGNLKNSLQQWFN-----IKDCLFEKNY-----

GCCDC1 VIIAPGEF---GMW---GQ-----VNRPNNTTFVHVVACSNATICAYPM---FNR-----WGPAGSIH---AENSFVEH-----NSSCF---LN-----

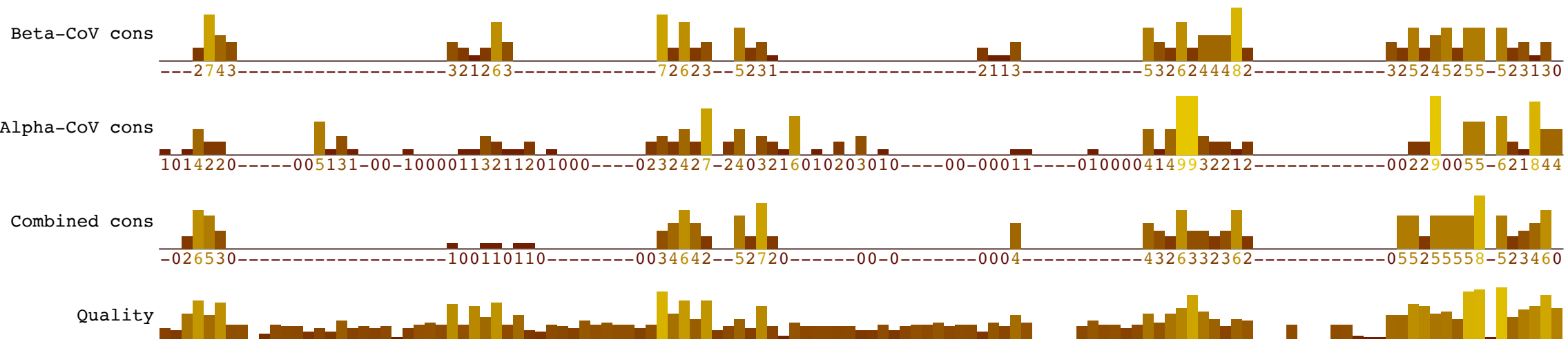
HKU14 VVQPHTTI-----SDKVLGLEI-SVCQYTMCEYPHT-----I CHPN-LG-NKRIELWHFDTD-----VVSCLYKRN-----

MHV APRYWVTPLVKROYLFNFNOKGVITSVAVDCASSYTSEIKCKTOSMLPSTGVYELSGYTVOPVGVVYRRVANLPACNIEEWLTARSVPSPLNWERKTFONCNFNLSLLRYVOAESLFCNNIDASKVY



390 400 410 420 430 440 450 460 470 480 490 500

229E VYFNGTG---RG-ACKGF-YS-NASSDVIRYNINFEF---NLRRGTILF-KTSYGAVVFYCTNNTL---VSGDAHIP---SGTVLGNFYCFVNTTI---G---NE---TTSAFV GAL-PKTVRE
NL63 VYFNATG---SDVNCNGY-QH-NSVVDVMRYNLFNSANSLDNLKSGVIVF-KTLQYDVLVFCNSSSS---GVLDTTIP---FGPSSQPYCYFINSTI---N---TT---HVSTFV GAL-PPTVRE
HKU8 VYFNGTA---PNKQCNGYATD-SAF-EALRFLSLNFTDERVFA-GSGSVLAL-LVSGLOQYKFCSTNNSE---AVIDSGIP---FGNVVEPFYCFVVSING---TSIFVGM L-PAV LRE
Ferret-CoV INFDTV-P---SQCNGA-TV-NGSFDVVRFLNFTANVASSSGTSFV LNTGGVVLYLSCFNETKTTNLYMSEGALP---FGTHEGALYCYVSYNE-----TSFKYIGVL-PPSVKE
CDPHE15 IYFNGT---NGAQCN GF-DS-NAPFDAIRFNLNGT LSG--HNFVSGFVLHAANGATLGFSCFNSTDA---PY-LRQIP---FGIGDTPIYCYLVNTT---D---IN---STMSFV GAL-PLN LRE
HKU10 VYFNLSR---SSAQCN GA-TE-NGLADALRFSMNF SRNG-FS-GAHS LTL-KG-AIDYVFRCTNNTN---VTSFY SIP---FGYIKTVYRCFVSYNS---T---NG---TVSEFV GAL-PP L VKE
BtRf-AlphaCoV IYFNITG---ANCNGFKDE-NAYADVLRFLSLNFTNSQVFN-GIHSVTV-NVVGDLKFCSCNTSTY---AESDEVL P---FGPLSSVYCYFVNGKL---G---ND---TFSRFV GAL-PPV VKE
LuchengRn-CoV ---SQQ-----Y-----AGVSYI-TWYNDHI---IA-----SI-----QGEVFTFDIG-----EVLQW--SNFSAFCGT
Mink-CoV FCFNTEDF---AQCN GY-RL-NSTADVIRFNLNFTHETVAASGTTFFELNNTGGVVLHISCYNQSRTE-AVTSEGFLP---FGYHENS LYCYVSYNE-----TLQKFLGVL-PPSVKE
Bat-CoV-1A VYFNMSM--NENVTCNGYSNFDVGVVDAMRFLSLNFTDNQII--RKGVISV-FTSTNVYNFSCSTNNSVL--DG--DAVIP---FGDVAQTHYCFIKYFT--N---ITSGESV SQFV GIL-PPQVKE
BtMr-AlphaCoV ITFDRNG--TSDVRCNGFASNE--TADAMRFLSLNFTDSAVFA-KEGVITL-KTLSNTFKFSCSNSSSTY--QA--PYVIP---FGHIDQPYCYFTTFYI--N---ETAGTTTTSFV GML-PPV VRE
BtNv-AlphaCoV IYFNSSRFTDPHQRCNGYNEV-GGLADHLRFAINVTD RGA F--QLGVISL-LAVHNAYNFSCSNISNF--VDATTIGVP---FGKTYQPYCYFVTEGY--N---ISA---NRTFV GVM-PSD VRE
Porcine-EDV FSNHTMD---GVCN GA-AV-DRAPEALRFNINDTSVI---LAEGSIVLHTALGTNLSFVCSNSSDP---HLAIFAIP---LGATEVPYCYFLKVD T--Y---NS---TVYKFLAVL-PPTVRE
BtCoV512 LSFDSPLN-VPGFSCN GA-NG-SSSAEAFRFNVNDTKLF---VGAGAVTLN TVDGVNVSVICSNNATQ---PTRSN---NLQEDLPYCYFTNTSS---G---TN---HTVKFLSV F-PP IIRE
HKU2 ---PSSQ---HK---G---GYMFGV-TWYND FV---RI---IF---PPTVFELQLD-----G-LQWEYVQFTGPVNA
NL63-related ISLSGVN---AD-KCN GH-SI-NETAGALRFNLNFTSNPINALASGKIFI-SSSFGNVTIFCSNSSDP--GSSADAFIA---MGSTSAAVYCFANSTF--G---NV---TSLDFIGVL-PVTVRE
FCoV FCFEGAQF---SQCN GV-SL-NNTVDVIRFNLNFTADVQSGMGATVFS LNTTGGVILEISCYSDTVSESSYSYGEIP---FGITDGPRYCYVLYNG-----TALKYLGTL-PPSVKE
TGE FCFEGAGF---DOCN GA-VL-NNTVDVIRFNLNFTTNVOSGKGATVFS LNTTGGVTLEISCYT--VSDSSFFSYGEIP---FGVTDGPRYCYVHYNG-----TALKYLGTL-PPSVKE
OC43 -TYDVNA-----DYL YFHFYQ-----EGGTFYA--YFTD-----TG VV-----TKFLFNVYLG-----MALSHYYVM-PLTCNS
MERS-CoV ---NITE---D-----EILEWF-----GITQT-AQGVHL----FSSRYVDL---YGGN-----MFQFATLPVY-----DTIKYYSII-PHSIRS
HKU1 -TYNVST-----DWLYFHFYQ-----ERGTFYA--YYAD-----SGMP-----TTFLFSLYLG-----TLLSHYYVL-PLTCNA
Covid-19 QPFLMDL---EGKQGNF-----KNLREFVFKN-----IDGYFKI--YSKHT-----PINL-VRDL PQG FSA-----LEPLVDLPIG-----INITRFQTL-LALHRS
Bovine-CoV -TYDVNA-----DYL YFHFYQ-----EGGTFYA--YFTD-----TG VV-----TKFLFNVYLG-----TVLSHYYVM-PLTCNS
HKU4 ---DITA---D-----ETKEWF-----GITQD-TQGVHL----YSSRKGD L--YGGN-----MFRFATLPVY-----EGIKYYTVI-PRSFRS
HKU5 ---TITE---D-----ENA EWF-----GITQD-TQGVHL----YSSRKENV--FRNN-----MFHFATLPVY-----QKILYYTVI-PRSIRS
HKU9 NTFSVNIS---T-----SRISLAFLF-----KDGDL LI-YHSGWL----PTSNFEHGFSRGSHP-----MTYFMSLPVG-----GNLPRAQFF-QSIVRS
SARS-CoV DAFSLDV---SEKSGNF-----KHLREFVFKN-----KDGFLYV-YKGYQ---PIDV-VRDLPSGFNT-----LKPIFKLPLG-----INITNFRAI-LTAFS-
HKU24 -TYNVAA-----DNIYFHFYQ-----DGTFYA--YVGD-----KSPI-----TTLLFQVYLG-----TVVTHYYVL-PLVCNA
Rat-CoV -TFNVNA-----EWLYFHFYQ-----QGGTFYA--YYAD-----VSSA-----TTFLFSSYIG-----AVLTQYFVL-PYMCNP
Bat-BCoV QSFNITSQ---GDKNGAFSK---DTITTYVFKY-----QNGIFSV-FHGFH----NGTD-----HVPY-----PKPAFEFPLD-----IPITHFIIP-PTVEE-
Hedgehog-CoV ---NVT D---D-----ERE EWF-----GIIQD-QQGVHL----YTSRKN-G--YSNN-----MFLFATLP IY-----DQILYYTVM-PRSINA
GCCDC1 DTFEIPMG---T-----SRVNLA FRF-----QDGNLLL-YHTAWL----PTENYTL--SGDYP-----LRYAR SVGVG-----SNLPFAQFF-QSVARA
HKU14 -TYDVNA-----DFLYFHFYQ-----EGGTFYA--YFTD-----TG FV-----TKFLFNVYLG-----TVLSHYYVM-PLTCDS
MHV GRCFGSISVDKFAVPRSROVDLQLGNSGFL OTANYKIDTAATSCOLHYTLPKNNVTINNHNPPSSWNRRYGFNDAGVFGKNOHDVVYAOCFTVRSYPCPAOPDIVSPCTTOTKPKSAFVNVDGHC



510 520 530 540 550 560 570 580 590 600 610 620 630

229E FVISRTGHFYINGRYFSLGSDVEAVNFNVTN---AA-TIVCTVALASYADVLVNVSQTAIANIIYCN-SVINRLRCDQLSFDVDPDGFYSTSPI--QPVELPMSIVSL-----

NL63 IVVARTGQFYINGFKYFDLGFIEAVNFNVTT---ASATDFWTVAFATFVDVLVNVSATNIQNLLYCD-SPFEKLOCEHLQFGLQDGFYSANFL--DDNVLPEYVAL-----

HKU8 IVITRYGSIYLNQFSIFQGPPIQGVLFNVTN---RGATDLWTVALSNTFEVLAEVSDTAIKALLYCD-DPLSQLKCSQQLSFDVDPDGFYATASL--FQHELPRTFVTL-----

Ferret-CoV IAVSKWGFVYINGYNYFQTFPIDSVAFNLT---GNSGAFWTIAYTTFDVLLEVDSTQIKSVTYCN-SHINDIKCSQMSENLDPGFYPVSQH--SLPNVNKTFVTL-----

CDPHE15 IVIASNGDVYMGYRYFAAGDLSSVDVELPSQ--QVFGSTFWTIAFTVFETVLLLEVSDGTSINRMLYCD-NPLNRVKCSHTQFDLVDGFYPLTDVDL--AVKPFVTFVTL-----

HKU10 IVVSRYGTIYLNQVRIKLPPLLEGVFNVTN---DVGSDFWTVAFQAQNAEVLLEVNATNIVNLHYCD-NTLNKKVCKQLSFDVDPDGFYPTTNL--VDSVVPKTYVAL-----

BtRf-AlphaCoV IVISRYGSFYMGVVKLFEVYPVESVFNVTN---SVGSDFWTVAYAQNTEVLLVNSTDIKDILYCD-TPANKLKCQQLSFDVDPDGFYPAALV--TGVEVPRTYVAL-----

LuchengRn-CoV -----GNKCGFSYATTLSEWLVRTDNDGTVIDYVICDTDFESQLKCKNMVFELTPAVYSGSAVE----LQSAIYYV--SNELPDCDFSADMF-----

Mink-CoV IAISKDGGFYINGYNYFQTFPIDCISFNLT---GNTGAFWTIAYTSYTDVMVDVENTAIKRVVYCN-SHIDDIRCNQLTPNLDPGFYPVSPK--AIGFVNKTFVTL-----

Bat-CoV-1A FVIMRNGDFHLNGYRIFSVDRVESAIFNIST---NDGRDFWTVAFANNAEVLTEINATSIQNLLYCN-NPVNSIKCQQLRFLNDDGFYSHTFD--SADNLPRTIVRL-----

BtMr-AlphaCoV FVITKTGNVYLNQYRIFTVDVVSFNFNIS---TDHRDFWTVAFVKNTEVMLDIEDTYIKQLLYCN-TPLNVVKCQQLKFLVDDGFYSYSSP--VDEVLPRTIVRL-----

BtNv-AlphaCoV IVVSRYGSVYINGYKIFNVGELYGVVLFNSS---LTGSDFWTVAYANEVNVLDIEETIITGILYCD-TPLNRLKCQQRFFMDDGFYSAI-D--LAPPVQTIIVLL-----

Porcine-EDV IVITKYGDVYVNGFYGLHLGLLDAVTINFTGHGTDVSGFWTIASTNFVDALIEVQGTSIQRILYCD-DPVSQLKCSQVAFDLDDGFYPISSRNLLSHEQPIISFVTL-----

BtCoV512 FVITKYGNVYVNGYIYLRTRPLTAVHLNASS--HSQDVAGFWTIAATNFTDVLVEVNNTGIQRLLYCD-TPENSVKCSQLSFELEDGFYSMTADNVYAVTKPHTFVTL-----

HKU2 -----GRMTKFNVTTEISSVLVLTQSGAVTRYSYCADGFVNGLQCKLRLFDIPPGVYSNSEVE----YPVALYTV--VHNMSVCPQRPESY-----

NL63-related FVFAATGQIYINGFNYFSLPDILSVDFDVKS---DNVDFWTVAYTQFVDTLVAVNNTLIQEVLYCD-DVIHKLKCSQLSFDLDPGFYSASLV--RDERLDKTFVTL-----

FCoV IAISKWGHFYINGYNYFFSTFPIDCISFNLT---GVSDFWTVIAYTSYTEALVQVENTAIKNVTYCN-SHINNICKSQLTANLNNGFYPVASS--EVGFVNKSVVLL-----

TGE IAISKWGHFYINGYNYFFSTFPIDCISFNLT---GSDVFWTIAAYTSYTEALVOVENTAIKNTVYCN-SHVNNIKCSOITANLNNGFYPVSSS--EVGLVNKSVVLL-----

OC43 -----KLTLEYWVTPLTSRQYLLAFNQDGIIFNAVDCMSDFMSEIKCKTQSIAPPTGVYELNGYT----VQPIADVYR-RKPNLPNCNIEAWLNDK-----

MERS-CoV I---Q-----SDRKA---WAAFYVYKQLPLTFLLDVSDGYIRRAIDCGFNDLSQLHCSYESFDVESGVYSVSSFE----AKPSGSVVE--QAEGVECDFSPLLSG--

HKU1 I-----SSNTDNETLQYWVTPLSKRQYLLKFDNRGVIITNAVDCSSSFFSEIQCKTKSLLPNTGVYDLGSGFT---VKPVATVHR-RIPDLPCDIDKWLNNF-----

Covid-19 YLTPG-----DSSSGWTAGAAAYYVGYLQPRFTLLKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFR---VQPTESIV-RFPNITNLCPFGEVFNAT-----

Bovine-CoV -----ALTLEYWVTPLTSKQYLLAFNQDGIIFNAVDCMSDFMSEIKCKTSLIAPSTGVYELNGYT----VQPIADVYR-RIPNLPCNIEAWLNDK-----

HKU4 K---A-----NKREA---WAAFYVYKHLQLYLLDFSDGYIRRAIDCGHDDLSQLHCSYTSFEVDTGVYSVSSYE----ASATGTFIE--QPNAATECDFSPMLTG--

HKU5 P---F-----NDRKA---WAAFYIYKHLPLTYLLNFDVEGYITKAVDCGYDDLAQLQCSYESFEVETGVYSVSSFE----ASPRGEFIE--QATTQECDFTPMLTG--

HKU9 NAI-D-----KGDGMCTNFDVNLHVAHLINRDLVSYFNNGSVANAADCADSAEELYCVTGSFDPPTGVYPLSRYR---AQVAGFVRVTRGRSCTPPYSVLQ-----

SARS-CoV -----PAQDIWGTSAAYFVGYLKPTTFMLKYDENGITITDAVDCSQNPLAELKCSVKSFEIDKGIYQTSNFR---VVPVSGDVV-RFPNITNLCPFGEVFNAT-----

HKU24 -----RQTYEYWVTPLIKREYLLVFDGNGVIITNAVDCASDHMSEIQCKTQNIKPNVGTGVYELTGYT---VQPIADVYR-RIPNLPCNIEAWLNDP-----

Rat-CoV T-----TSG--VFSPQYWVTPLVKRQYLLFNFNQKGIITSAVDCASSYTHSEIKCKTQSMNPNTGVYDLGSGYT---VQVPLGLVYR-RVRNLPCNIEAWLAN-----

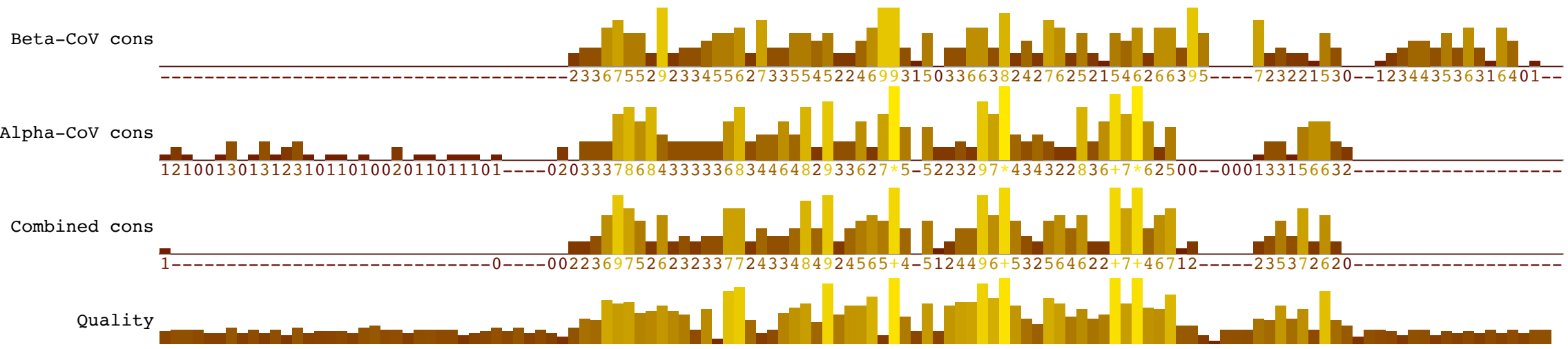
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Hedgehog-CoV SN--Y-----ASYHA---FSAFYIYKHLKINYMVDFDVNGYITRAVDCGYNDYTQLQCSYGFQDMDSGVYSASYFN---ARSRGYEY--AAELTECDLVDLDFKN--

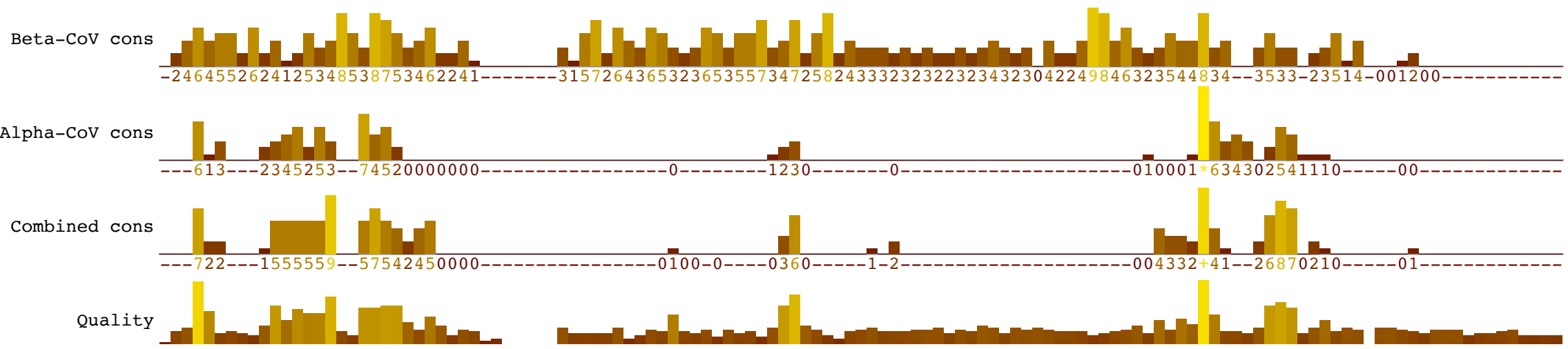
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HKU14 -----TSLLEYWVTPLTPRQYLLAFNQDGIIFNAADCMSDFMSEIKCKTQSIAPPTGVYELNGYT---VQPIADVYR-RIPNLPCNIEAWLNDK-----

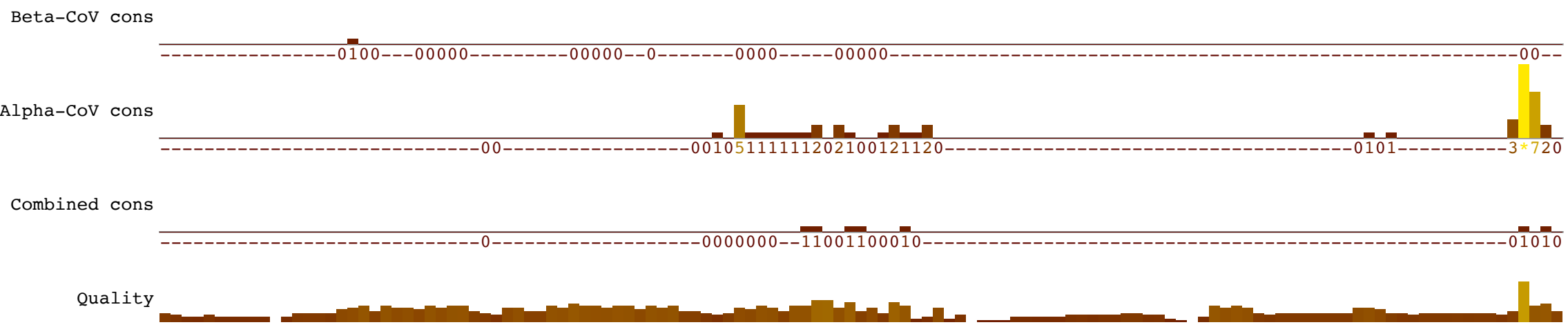
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| | 640 | 650 | 660 | 670 | 680 | 690 | 700 | 710 | 720 | 730 | 740 | 750 | 760 |
|---------------|------------------------------|------------------------------------|--|--|---------------------------------|---------------------------------|---------------------------------|--------------------------|------------|---------------|-------------|-----|-----|
| 229E | PVY | HKHTFIV | LHVKFEHQ | RG | GKCYNCRPSVI | NITLA | NFN | ETKGPL | CVDTSHF | TTQFVD | NV | | |
| NL63 | PIY | YQHTDIN | FTAT | ASFG | GSCYVCKPHQV | NISLN | G | NTSV | CVRTSHF | SIRYIY | NR | V | |
| HKU8 | PRH | FTHSWIN | LRIKWKN | | GVCYNCPASSW | IDFVTFNSNGT | ENV | LPERTL | CVNTTQFT | TNLT | IE | E | |
| Ferret-CoV | PAN | FEHTSIN | VTGNVLLIYYA | | HPVF | R-SGNVTLH | P | QGTQTI | CVNTTQFT | TFNFDL | QCHOLA | | |
| CDPHE15 | PTF | ADHSFVY | FNFSLMFDDL | E | D | FRLQSFNL | T-I | NGQLSY | CVQSRQFT | TSGSV | RT | N | |
| HKU10 | PYH | ATHTYIE | LNITVNY | VRD | E | IAL | T | GGGELT | CVNTTQFT | TTLFST | NA | A | |
| BtRf-AlphaCoV | PYH | ATHMFVN | LTVHLGN | SVDADA | Y | VQI | N | GVNDTV | CVNTTQF | STHFQQ | LD | | |
| LuchengRn-CoV | DGTGNF | EGLRRHVFS | NCWVNYTAWFACAD | DY | SCIIFNA | IFAEVR | YKLSQPDG | LVN | PFIK | CNGLDLYSITKG | | | |
| Mink-CoV | PAN | FDHVYVN | ITGNVRLKIQR | G | RPYN | N-GGNATLS | F | Q | GCIDVS | QFTVNVNH | TCTLID | A | |
| Bat-CoV-1A | PKY | VTHSYIN | VTVGVMFENGT | | LTNYL | VDFAPDGTSIGK | | DNITTV | CVDTTFT | TTRLNV | LA | F | |
| BtMr-AlphaCoV | PRL | MTHNFLN | FTIFVSFYFDDDKQARPDGGFYECATCAPKYYK | | LAFVDD | WTSAVS | | SNVTSI | CVNYASF | TTRLFT | FY | A | |
| BtNv-AlphaCoV | PEY | TGLTNIT | LDVNVTFNPP | SCIQC | APTUNS | ILLN | G | ESGGSV | CVSTNRF | SVDFKL | TV | | |
| Porcine-EDV | PSF | NDHSFVN | ITVSAAFGGLS | S | A | NLVASDT | T-I | NGFSSF | CVDTRQFT | TITLFY | NV | T | |
| BtCoV512 | PTF | NDHGFVN | VTVGGMFDSSY | P | P | KFTANGT | L-V | NNGTVV | CVTSNQFT | LRHDF | MV | G | |
| HKU2 | CGSNYCPFKRVVFS | NCVNYT | SWTSGLL | | RDY | QHLVLPNG | KFN | PFTE | CENGLN | RIVDD | | | |
| NL63-related | PTH | SDHSNVT | LYVSFNTYSSS | TC | TTKPDHVT | SCQYNTV | IVG | ENDGPV | CVKSKQFT | PLLQT | S | | |
| FCoV | PSF | FTYTAVN | ITIDLGMKLSGYG | | QPIAST | LSNITLP | MOD | NNTDVY | CIRSNQFS | SVVHS | TCKSSLWDNIF | | |
| TGE | PSF | YHTTIVN | ITIGLGMKRSGYG | | OPIAST | LSNITLP | MOD | HNTDVY | CIRSDOFS | SVYVHS | TCKSALWDNIF | | |
| OC43 | SVPSPLNWERKTF | SNCNFMSS | LMSFIQ | ADSFT | CNNIDA | AKIYGMCFSSITIDKFAIPNGR | KVDLQLG | NLGYLQSFNYRIDTTATSCQL | YYNLPAANVS | VSRFNPSTWNKRF | G | IE | |
| MERS-CoV | TPPQVYNFKRLVFTNCN | YNLTKLLSLFS | VNDFTCSQISPAAIASNCYSSLILDYFSYPLSMKSDLSVSSAGPISQFNKQSFNSPTCLI | LATVPHNLT | ITKPL | | | | | | | | |
| HKU1 | NVPSPLNWERKIF | SNCNFNLS | TLLRLVH | TDSF | SCNNFDESK | IYGS | CFKSIVLDFKFAIPNSRRSD | LQSGSSGFLQSSNYKIDTSSSSQL | YSLPAINVT | INNYNPSSWNR | RY | G | FNN |
| Covid-19 | RFASVYAWNKRKISNCVADYSVL | YNSAS | FSTFKCYGVSPTKLN | DL | CFTNVYADS | FVIRGDEV | RQIAPGQTGKIADYNYKLPDDFTGCVI | AWNS | NNLDS | KVGGNY | | | |
| Bovine-CoV | SVPSPLNWERKTF | SNCNFMSS | LMSFIQ | AYSFT | CNNIDA | AKIYGMCFSSITIDKFAIPNGR | KVDLQLG | NLGYLQSFNYRIDTTATSCQL | YYNLPAANVS | VSRFNPSTWNR | RF | G | FTE |
| HKU4 | VAPQVYNFKRLVFSNCN | YNLTKLLSLFA | VDEF | SCNGISPDSIARGCYSTLTVDYFAYPLSMKSYIRPGSAGNIPLYNYKQSFANPT | CRV | MASVLANV | T | ITKPH | | | | | |
| HKU5 | TPPPIYNFKRLVFTNCN | YNLTKLLSLFQ | VSEF | SCHQVSPSSLATGCYSSLTVDYFAYSTDMSSYLQPGSAGAI | VQFNKQDFSNPT | CRV | LATVPQNLTT | ITKPS | | | | | |
| HKU9 | DPPQPVVWRRYMLYDCV | FDFTVVVD | SLP | THQL | QCYGVS | PRRLASMCYGSVTL | DVMRINETHLNNLFNRVPDTFSLYNYALPDN | FGCLH | AFYL | NSTAP | YAVA | | |
| SARS-CoV | KFPSVYAWERKKISNCVADYSVL | YNSTF | FSTFKCYGVSATKLN | DL | CFSNVYADS | FVVKGDDV | RQIAPGQTVIADYNYKLPDDFMGCVL | AWNT | RNIDA | TSTGNY | | | |
| HKU24 | QVPSPI | SWERKTF | SNCNFMSS | LLSKVR | ATSF | SCNNIDASKIYDMCFGSITIDKFAIPNSRRV | DLQFGSSGYIQNYR | LDQSATSCQL | YIGIPANNVT | VTKKNPSGWN | RY | G | FVE |
| Rat-CoV | TVPSPLNWERKTF | QNCNFNLS | LLRFVQ | AESL | SCSNIDASKIYDMCFGSITIDKFAIPNSRRV | DLQFGSSGYIQNYR | LDQSATSCQL | YSLAQNVT | VINHNPS | SWNR | RY | G | FND |
| Bat-BCoV | ATIPSPAFWRRHYVRNCNYDISV | FTDNAD | VYSL | QCYGVAPSSLADMCWEEAHIDYMKISEK | DIFSFKPSGAGDFAKYNYKLP | PSDFMGCTV | VFTN | QELTC | NATSGQL | | | | |
| Hedgehog-CoV | DAPIIANYSRRVFTNCN | YNLTKLLSLVQ | VDEF | VCHKTTPEALATGCYSSLTVDWFALPFSMKSTLAIGSAEAI | SMFNQDYSNPT | CRI | HAAVTANVSTALNFTANA | | | | | | |
| GCCDC1 | EPPSPA | AVRATISNCTFDFES | LLRTP | TYNL | KCYGISPARLSTMCYAGV | TLDIFKLN | TTHLSNMLGSVPDAVSIYNYALPSN | FGCVH | AYHL | NSTTP | YAVA | | |
| HKU14 | SVPSPLNWERKTF | SNCNFMSS | LMSFIQ | ADSFT | CNNIDA | AKIYGMCFSSITIDKFAIPNGR | KVDLQLG | NLGYLQSFNYKIDTSATSCQL | YYNLPAANVS | VSRLNPSTWNR | RF | G | FTE |
| MHV | GRVSAAFHKDAPEPALLYRNINCSYVFS | NNISREENPLNYFDSYLGCVVNADNRTDEALPNC | DLRMGAGLCVDYSKSRRAHRSVSTGYRLTTFEPYTPMLV | NSVOSVDGLYEMOIPTNFTIGHEE | | | | | | | | | |



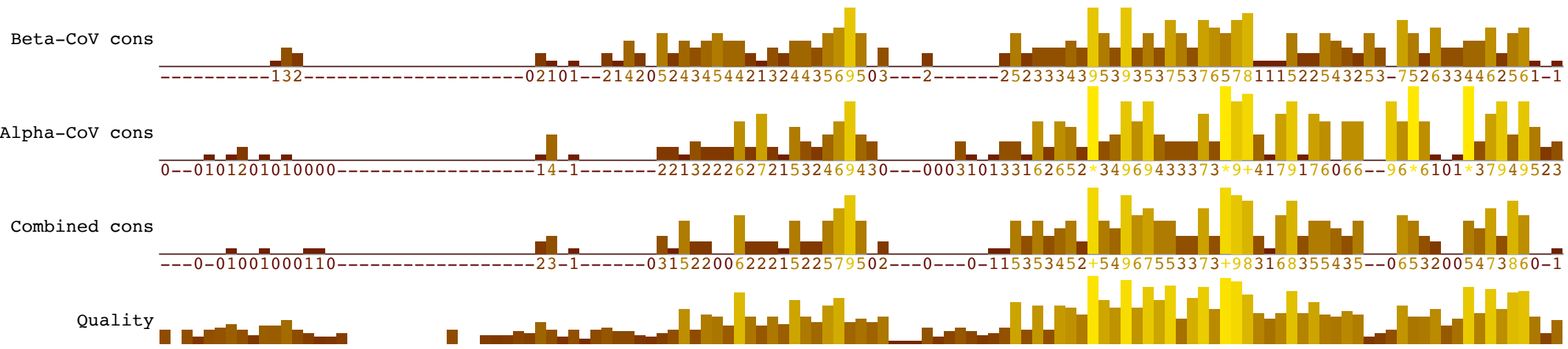
| | 770 | 780 | 790 | 800 | 810 | 820 | 830 | 840 | 850 | 860 | 870 | 880 | | |
|---------------|---|---------|----------|----------|-----------|-------------|-----------|----------|----------|-----------|----------------|---------------------------------|----------------------------------|-------|
| 229E | | | | KL | | ARWSASINTGN | CPFSFGKVN | NFV | | | KFGS | VCFSL | | |
| NL63 | | | KSGSPGD | | | SSWHIYLKSGT | CPFSFSKL | NNFQ | | | KFKT | ICFST | | |
| HKU8 | | | AFS | | | YSTPVVVRADD | CPDFQSL | NNYL | | | TFGS | ICFSL | | |
| Ferret-CoV | | | GGGCDGI | | | GASMISIDSGN | CPFSPDKL | NQHL | | | AFET | LCFST | | |
| CDPHE15 | | | TNH-QF | | | GFYTQRAASNG | CPFTIDTL | NNYL | | | TFGR | ICFSF | | |
| HKU10 | | | TDG | | | NTYEGVVINVN | CPDFDNL | NNYL | | | SFDS | ICFSL | | |
| BtRf-AlphaCoV | | | TS | | | NTISALMQNGD | CPFNFDL | NNFL | | | SFDS | ICFNL | | |
| LuchengRn-CoV | | | CSSGFVLR | QLYANGS | FVNSYT | | | | | PDYM | | ECF | | |
| Mink-CoV | | | NGQCTGA | | | YEARVYVTS | SGSCPF | AFDRL | NNHM | | SFSK | ICFSP | | |
| Bat-CoV-1A | | | SA | | | FSTAVDIQAGT | CLFSYNN | LNNYL | | | GLVS | LCFST | | |
| BtMr-AlphaCoV | | | GTT | | | AGVHLGLETGT | CPFSFDL | TNNYL | | | TFGS | LCFSL | | |
| BtNv-AlphaCoV | | | NS | | | QAYDIGVRTG | SCPFYGS | LNNFV | | | KFGS | ICFSL | | |
| Porcine-EDV | | | NSY-G | | | YVSKSQDSN | CPFTLQS | VNDYL | | | SFSK | FCVST | | |
| BtCoV512 | | | YSA-DM | | | RKGIFEYSST | CPFNRET | INNYL | | | TFGR | ICFST | | |
| HKU2 | | | CVTGFVLR | VGRGTAVN | RTVITPY | | | | | LKPN | | ECF | | |
| NL63-related | | | IP | | | TGYVSVESG | SCPFNFKL | LKNNYL | | | TFDS | LCFST | | |
| FCoV | | | NQDCTDV | | | LEATAVIKTGT | CPFSFDL | NNYL | | | TFNK | FCLSL | | |
| TGE | | | KRNCTDV | | | LDATAVIKTGT | CPFSFDL | NNYL | | | TFNK | FCLSL | | |
| OC43 | DSVFKPRPAG-VLTNHDVVYAQHCFKAPKNFCPCKLN | GS-CVGS | GP | GK | | NNGIGTCPAGT | NYLTCD | | | NLCTPDPIT | FTGTYKCPQTKSLV | GIGEHCSGLAVKSDYCGGN | | |
| MERS-CoV | | | KYSYINKS | RLLSDDR | TEVPQLV | NANQYSP | CVSIVPS | TVWEDG | YYRQ | | | LSPL | | |
| HKU1 FN | | | LSSHVVY | SRYCFSV | NNTFCPCAK | PSFASS | CKSHKPP | SASCPIGT | NYRSCE | STTVLDHTD | WCRCSCLPDPITA | YDPRSCSQKSLVGVGEHCAGFGVDEEKCGVL | | |
| Covid-19 | | | NYLY | | | RLFRKSNL | KP | FERD | ISTE | IYQ | AGST | PCNGV | | |
| Bovine-CoV | QSVFKPQAG-VFTDHDVVYAQHCFKASTNFCPCKLDGSL | CVGNG | PGIDAGYK | TSGIGT | CPAGT | NYLTCHN | | | AAQCDCL | CTPDPITSK | ATGPKYKCPQTKYL | VGVGEHCGLAIKSDHCGGN | | |
| HKU4 | | | AYGYISK | SRLTGANQ | DVETPLY | INPGEYSI | CRDFSPG | GFSE | DQVFKRT | | | LTQF | | |
| HKU5 | | | NYAYL | TECYKTS | AYG | KNYLYN | APGAYTP | CLSLASR | GFSTKY | QS | | | | |
| HKU9 | | | NRF | P | | I | | | K | | PGGR | QSN | | |
| SARS-CoV | | | NYKY | | | RYLRHGK | LRP | FERD | ISNV | PFS | PDGK | PCTP | | |
| HKU24 F | | | KPLNIGQ | NYNKYS | AIYSTM | CNFVNDY | CCKLGCPT | GTVERPQ | IGTSTSG | QPIYDCPG | | YP | WLTSSACKQTPATVGVGQYCPGVGMADQCAPS | |
| Rat-CoV | VATFG | | SGIHDV | AYAEAC | FTVGAS | YCPCAK | PSIVYS | CVTGKPK | SANCPTGT | SHRECN | VQA-SGFKHK | CDCTCNPSPLT | TYDPRCLQARSMLGVGDHCEGLGILEDKCGGS | |
| Bat-BCoV | | | CHVY | TNNLT | NYPAEA | | TAWDK | SHYES | IERY | QMWS | SENVYNCELQE | | VGPO | QFN-R |
| Hedgehog-CoV | | | NYAY | ISRCQ | VDGK | | PILLQ | PGQMTNI | ACRSG | VLA-R-PSD | ADYFGY | | SF | |
| GCCDC1 | | | VP | PGAYP | | I | | | | K | | PGGR | QLF | |
| HKU14 | QSVFKPQAG-VFTAHDVVYAQHCFKAPTTFCPCKLDGSL | CVGSG | SGVDAG | FKHTG | IGT | CPAGT | NYLTCYN | | | SVQCNCQ | CTPDPILSK | ATGPKYKCPQTKYL | VGVGEHCGLAIKSDYCGGN | |
| MHV | FIOTRSPKVTIDCAAFVCGDNTACROOLVEYGSFCVNV | NAI | NEVNNLL | DNMOL | OVASAL | MOGVT | ISSRL | PDG | ISG | PIDDIN | FSPLLGCIG | ISTCAEDG | NGPSAIRGRSAIEDLLFDKVKLSDVGFVE | |



900 910 920 930 940 950 960 970 980 990 1000 1010

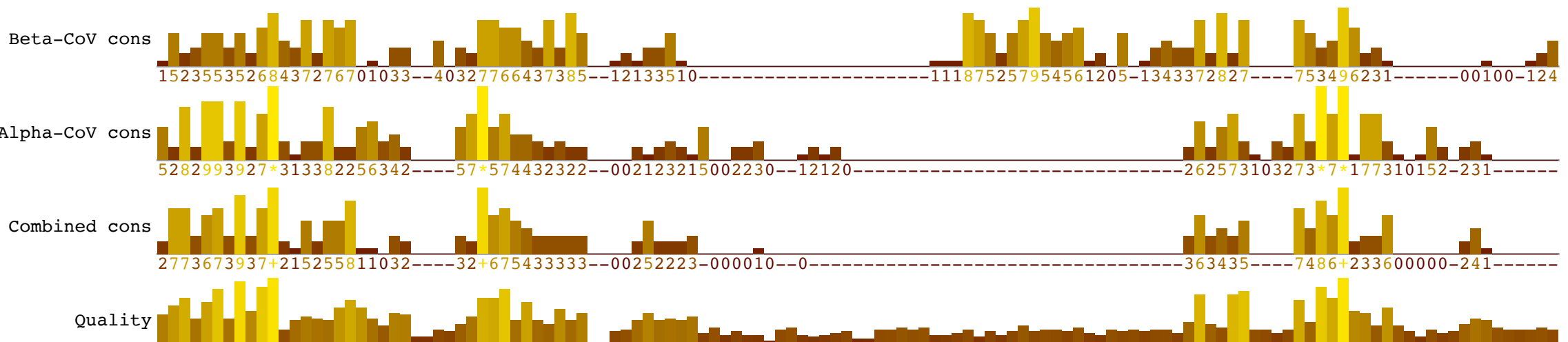
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Ferret-CoV L-PTGSDCAFSLTVQN-----RYFT---RVFAHLFVYTKYGLDHLGVQT---PDVGVKDLVSVYHQNVCTSEYNIYGHAGVGIIRSTNQTLLGG--LYYTSLSGDLGFKNV
CDPHE15 G-ESGAGCGVDVMVES-----QYNM---FKVTTIFVSYSEGDIIAGMPK---PSEGIKRVSKIHLVDCSTYSIYGHGTGDIIRLTNDTLLGG--LYYTSVPGALLGFKNV
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BtRf-AlphaCoV Q-PVGSSCTISIMKNW-----MG-F---KAPWKSVMYVTFKRGNRITGVKN---ASTGIFDPSVMQLNECTDYTIYGVSGRGIIRKANSSYISG--LYYTSIAGQIIGFKNA
LuchengRn-CoV -----GYFALY---NGYVIYN---AKFVSKGLTVCVVQ-----PVEPELDVCKSYTIDGVTFQGILRNTTHQIDSFHNILYY---GDMVSYV-R
Mink-CoV V-PLGDDCRLDLTVQT-----RYFT---GVFAHVYVSYKFGLDIVGLPR---ADAGLKDLSVLHLNVCTEYNVYGFAGTGIIRETNQTVMG--LYYTSLSGDLGFKNV
Bat-CoV-1A K--PNGGCMMSVVARG-----YFGE---FQKGVLYVSYFTKGDVNLGVPPNNIPTIGVSDMSDVKLVNCTTFTIYGHGTGRGIINKSNNTFVSG--LFYTSVTGNLLGFKNS
BtMr-AlphaCoV V--ANGGCTMNIVTQG-----PYGL---PHTIAVLYVSYTEGDNIIIGVPLSNIPPLGVSDMSQVYLDCTTYTYIYGMTGRGVITRSNNTFITG--LYYTSNAGNLLAYKNS
BtNv-AlphaCoV V--DNGGCPMPINAIN-----YIKI---EYPIGVLYVTHSPGEAITGVPKGFIKRLGFLDASILHLNVCTEYNIYGVGKGIINKANSTLHTG--IVYTDTAGVLSVFKNV
Porcine-EDV S-LLAGACTIDLFYGP-----AFGS---GVKL-TSLYFQFTKGLITGTPK---PLEGITDVSFMTLDVCTKYTIYGFKGEIITLTNSSLILAG--VYYTSDSQLLAFKNV
BtCoV512 S-PADGACELKYYVWN-----TIGA---VSHLAGTLYVQHTKGDIIITGTPK---PLQGLNDISELHLDCTTYTYIYGFGRGDGVIRLTNQTFLSG--VYYTSESGQLLAFKNV
HKU2 -----GWSWND---YQDSIYDWWI---ADFVSTGAFVCEKN-----PDAPRTGVCITYTIEKVTTFQGVLYESNFTFAQYVNVLYF---GSOLKYV-R
NL63-related K-QLPGGCSMLIKRSN-----VN-Y---NSDIGVIYVSHSPGNNILGVQP---ASTGVKDLVSVYVTDVCTDYTIYGKSGKGVIRKTNSSLPAG--IMYTSSESGLLGFKNV
FCoV S-PVGANCKFDVAART-----RTNE---QVVRSLYVIYEEGDNIVGVPV---DNSGLHDLVSLHLDSDCTDYNIYGRGTGVGIIRRTNSTLLSG--LYYTSLSGDLGFKNV
TGE S-PVGANCKFDVAART-----RTNE---QVVRSLYVIYEEGDNIVGVPV---DNSGVHDLVSLHLDSDCTDYNIYGRGTGVGIIROTRNRTLLSG--LYYTSLSGDLGFKNV

OC43 -----SCTCRPQ-----AFLGWSADS-CLQGDKCNIFANFILHDVNSGLTCTSTD---L---QKANTDIIILGVCVNYDLYGILGQGFIVEVNATYYNSWQNLLYDSNGNLYGFRDY
MERS-CoV ---EGGGWLVASG-----S-----TVA---MTEQLQMGFGITVQYGTDTNSVCPKL---EFAND-TKIASQLGNCEVYSLYGVSGRQVFNCTAVGVRQQR-FVYDAYQNLVGYI-S
HKU1 ---D-GSYNVSCLCSTD-----AFLGWSYDT-CVSNRRCNIFSNFILNGINSGTTCSND---L---LQPNTEVFTDVCVDYDLYGITGQGFIFKEVSAVYNSWQNLLYDSNGNIIGFKDF
Covid-19 ---EGFNCFYPLQSYG-----F-----QPTNGVGYQP-YRVVLSFELLHAPATVCGPK---K-----STNLVKNKCVNFNFNGLTGTGVLTESNKKFLPFQO-FGRDIADTTDAVRDP
Bovine-CoV -----PCTCQPQ-----AFLGWSVDS-CLQGDRCNIFANFILHDVNSGTTCTSTD---L---QKSNTDIIILGVCVNYDLYGITGQGFIVEVNATYYNSWQNLLYDSNGNLYGFRDY
HKU4 ---EGGGLLIGVG-----T-----RVP---MTDNLQMSFIIISVQYGTGTDVCPML---DLGDS-LTITNRLGKVDYSLYGVGTGRGVFNCTAVGVKQQR-FVYDSFDNLVGYI-S
HKU5 ---HSDGELTTTG-----Y-----IYP---VTGNLQMAFIIISVQYGTGTDNSVCPMQ---ALRND-TSIEDKLDVCEVYSLHGITGRGVFHNCTSVGLRNQR-FVYDTFDNLVGYH-S
HKU9 -----SAFIDTV-----I-----NAAHY-SPFSYVYGLAVITLPAAGSKLVCP-V---AN-----DTVVITDRCVQYNYLYGYTGTGVLKSKNTSLVIPDGKVFTASSTGTIIGV--S
SARS-CoV ---PALNCYWPLNDYG-----F-----YTTTGIGYQP-YRVVLSFELLNAPATVCGPK---L-----STDLIKNCVNFNFNGLTGTGVLTPSSKRFQPFQO-FGRDVSDFTDVSRDP
HKU24 ---MPGNSILTCSCSNTQYSAGNSQPYYYAWTSFGADT-CLSGGNCQVFANVLLNNGVNSGTTCCATD---L---QKANTEIIVGCVKYLIDYGISGQGFIFTEVNATYYNSWQNLLYDSNGLYGFKDF
Rat-CoV -----N-----ICNCSAD-----AFVGWAKDS-CLSNDRCHIFSNLMLNNGINSGTTCTSTD---L---QLPNTEVTVGVCVNYDLYGITGQGFIVEVNATYYNSWQNLLYDVNGNLNGFRDI
Bat-BCoV ---MPRNCYVRSNNSND-----Y-----WQPMSFRGVNSLMVAMAITLKPTRTSATVCGYK---QK-----TTPVLVNECITYHIYGYKGTGVIIVSANYYTFQSFQT-VQLTSTGSLHSF--K
Hedgehog-CoV ---QGRNYLGRK-----S-----YKPKT--DEGDVQMVYVITPKYDKGPDVCPK---DMGAASSSLDGLLQCIDYDIHGTVVGRGVFQVCNNTGSIASQI-FVYDGFNIIGFH-S
GCCDC1 -----NSFVSQV-----L-----DSPTSQCTPANCMGVVIGLTPASGSNLVCP-K---AN-----DTQVIEGQCVKYNFYGYAGTGVINQ-SDLAIIPNNKLFVTSKSGAVLAV--R
HKU14 -----PCTCQPQ-----AFLGWSVDS-CLQGDRCNIFANLILHGVSNGTTCSTD---L---QKANTDIIIVGVCVNYDLYGISGQGFIVEVNATYYNSWQNLLYDSNGNLYGFRDY
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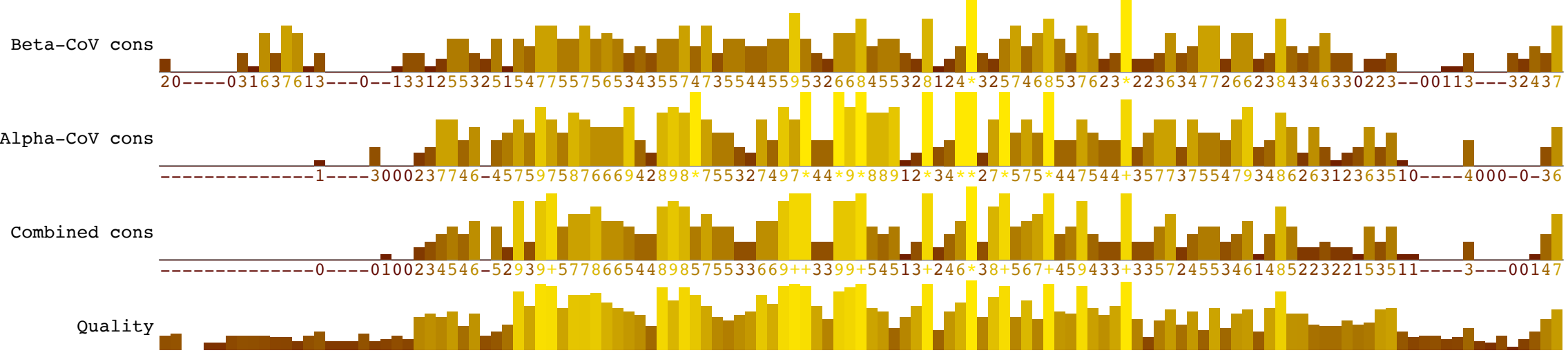
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HKU8 TTGEVFSVTPCNPSQAVVVKDR---LVGVMSSSTSTVS--IPFNNTIPTPSFYH--SNATS-----SCDDPSVVYSSIGICDDGGITFVN-STR-----
Ferret-CoV TTGEVYSIVPCQLSAQAAVINGK---IVGAVTSVQSPI--LDLPHHIVTPQFYHHSIYNSATPTSYRTNNGFDKYL-----VNCTPIITYSNMGVCENGALVFIN-ITQ-----
CDPHE15 TTGEIYSVTPCSLTQOVAVVSD---IVGVSSSANVSDQFSFTYTTVTEQFYFM--TDGNS-----SCSEPVLTYSSGLGVCKDGLRILQ-PRE-----
HKU10 TTGVLYAVEPCDTSSQVAVYGDA---IIGAMTSSANVT--FGFVNTTVLPSFYH--TNGFG-----GCQTPVLEYGSMGLCADGSVVDVT-LRQ-----
BtRf-AlphaCoV TTGEVFSVTPCQLTMQAAVVND---IVGVSSSTNTSG--INFTHITTKTFYH--TNVQQ-----NCSEPVLTYANIGVCSGDSITEVT-VRK-----
LuchengRn-CoV IRGVVYAVESCNRFYYS-VFKTL---SAIGYLYSGATCD--STDVTTTMT-----KA--RA---TTFVDSLGCFFIDVSV-TDGNVTDCLNPI----GNFCVDVNVGTQPPVGN-----
Mink-CoV TTGTVYSITPCELSAQAVIDGS---IVGAITSVNSEL--LGLKNHIVTPYFYYSVYNYTADNN---SRSMQKYD-----VNCTPVISYSNMGVCANGALVFIN-VTH-----
Bat-CoV-1A TTGEIFSIISPCQLTTQVAAVSDK---IVGVAAATKEVT--LPFDTHVSLGFSFYHYKNSNAE-----LCKNPSLMYGGLGVCEDGRLVNIS-RSE-----
BtMr-AlphaCoV TTGVVYNVYPCQLSSQVAVISDA---IVGMASSTPNVS--IDFNVTVVADNFYLL--SNSAQ-----PCDQPVLTAYAGIGICSDGSITNST-ARR-----
BtNv-AlphaCoV TTGDIYSVIPQTSMQYAVIADN---IVGVISADTATG--ITFNHTIATPMFYYS--TNTDR-----NCTEPVLTYATMGICADGAIGYVQ-PRV-----
Porcine-EDV TSGAVYSVTPCSFSEQAAYVND---IVGVISLNSNST---FNNTRELPGFFYH--SNDGS-----NCTEPVLVYSNIGVCKSGSIGYVP-SQY-----
BtCoV512 TTGQIYSVTPCQLVQVAFVEDR---IVGVISSANNTG--FFNSTRTFPGFYH--SNDTT-----NCTSPRLVYSNIGVCTSGAIGLLS-PKA-----
HKU2 ILGKVYEVAPCFEASVDVLFSS---SSFGLLYRSFDCN--QLRISASRF-----AE--RLLPSHNGTATALGCLFNATYAPNDTMVNCNTNPL---GDGFCADLL--SNVVRR-----
NL63-related TDSTVYTVTPCATATQLAVYKQK---VLGAITAVKNS--FGFNSTLTLPLFYH--SNGKV-----NCTEPILVYSSIGICPDGMTIQIK-PVE-----
FCoV SDGVIYSVTPCDVSAQAVIDGA---IVGAMTSINSEL--LGLTHWTTTPNFYYSIYNYTSETR---GTAIDSND-----VDCEPVITYSNIGVCKNGALVFIN-VTH-----
TGE SDGVIYSVTPCDVSAQAVIDGT---IVGAITSINSEL--LGLTHWTTTPNFYYSIYNYTNDTR---GTAIDSND-----VDCEPVITYSNIGVCKNGAFVFIN-VTH-----
OC43 ITNRTFMIRSCYSGRVSAAFHAN--SSEPALLFRNIKCN--YVFNNSLT-----RQLQPINYFDSYLGCVVNAYNSTAISVQTCDLTV---GSGYCVDYD-----KNRRSRGAIT
MERS-CoV DDGNYCYLRACVSVPSVVIYDKE--TKTHATLFGSVACE--HISSTMSQYSRSTRSMLK-----RRDSTYGPLQTPVGCVLGLVNSS-LFVEDCKLPL---GQSLCALPDPSTL-TPRSVRSVP
HKU1 VTNKTYNIFPCYAGRVSAAFHQ--ASSLALLYRNLKCS--YVLNNIS-----LTTQPYFDSYLGCVFNADNLTDSVSSCALRM---GSGFCVDYNSPSSSSSRKRRSIS
Covid-19 QTLEILDITPCSFSGGVSVITPGTNTSNQAVLYQDVNCT--EVPVAIHADQLTPTWRVYSTG-----SNVFQTRAGCLIGAHE-V-NNSYECDIPI---GAGICASYQTQNS-PRRAR-SVA
Bovine-CoV LTNRTFMIRSCYSGRVSAAFHAN--SSEPALLFRNIKCN--YVFNNTLS-----RQLQPINYFDSYLGCVVNADNSTSSVVQTCDLTV---GSGYCVDYD-----TKRRSRRSIT
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HKU9 INSTTYSIMPCVTVPSV---GYHPNFERALLFNGLSCS--QRSRAVTE-PVSVLWSASATA-----QDAFDTPSGCVVNVELRNTTIVNTCAMPI---GNSLCFINGSIATA-NAD---SLP
SARS-CoV KTSEILDISPCAFGGVSVITPGTNASSEVAVLYQDVNCT--DVSTAIHADQLTPAWRIYSTG-----NNVFQTAGCLIGAHE-V-DTSYECDIPI---GAGICASYHTVSL---LR-STS
HKU24 LTNRTYMRSCYSGRVSAAYHSD--TDEPALLYRNLKCS--YVFNNNIS-----ISRSVIRYFDSYLGCVVNADDDIAEAVGSCNLTV---GSGYCVDYD-----STWRARLDLN
Rat-CoV VTNKTYLLRSCYSGRVSAAYHQD--APEPALLYRNLKCD--YVFNNNIS-----REETPLNYFDNYLGCVVNADNSTEHSVDACDLRM---GSLCVNYS-----TAHRARRSVS
Bat-BCoV YNNTIYGILPCAQAQVSVITAGSNHD-NVAVVYNGLGCN--AFQSKMQG-VDNTEWSVYTNF-----SSPIDTPVGCLTGAIQAQ--ENSTECQFAL---GLDSCVNYTADTRL-RT-AR-AAD
Hedgehog-CoV KNGTYCYMAPCVSVPSVVIYDKS--SDVHATLYSSVECN--HIKSVATVFSRQTESKLR-----S--SDNGLLQTAVGCVIGFRNTS-DTVEDCTLPL---GQSLCAKPPSFSSR-STN---VN
GCCDC1 AGDKVYSITPCVSVPIVSV---GYDPGHQRALVFNGLDCS--ARANAVSM-PASEYWTAASST---TARGSEPVLDTPSGCVYVNNCTTHTVSVCEMPI---GNSLCLVSNFTCSV-VATASLSPN
HKU14 LTNRTFMIRSCYSGRVSAAFHAN--SSEPALLFRNIKCN--YVFNNTF-----RQLQPINYFDSYLGCVVNADNSTASTVQTCDLTV---GSGYCVDYD-----TQLRSRAIT
MHV SNRFGAISASLOEILTRLEAVEAKAOIDRLINGRLTALNAYISKOLSDSTLIKVSAAOAIEKVNCEVKSOTTRINFCGNGNHILSLVONAPYGLYFIHFSYVPISTTTANVSPGLCISGDRGLAPKA



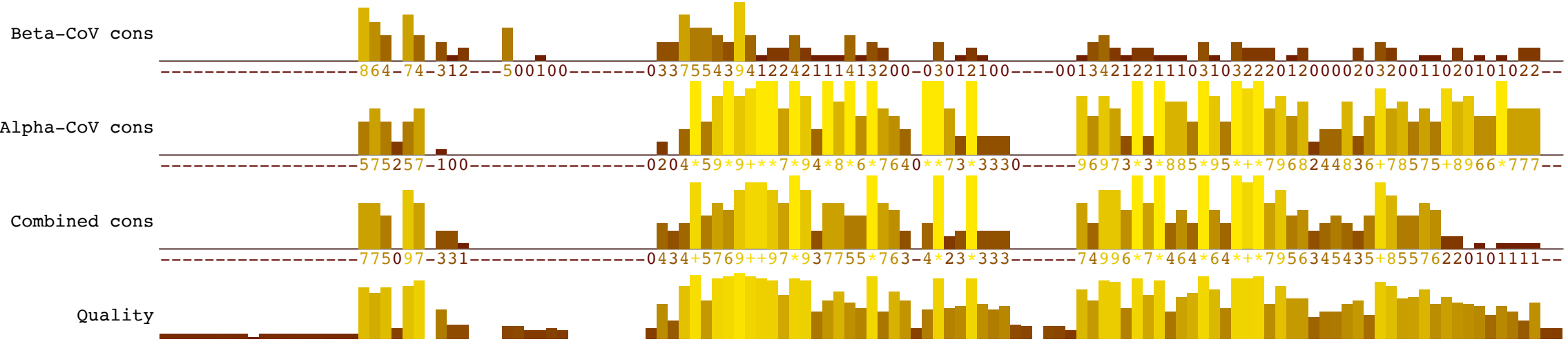
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NL63 -----S---SDNGISAIIT-ANLSIPSNWTTTSVQVEYLQITSTPIVVDCAITYVCNGNPRCKNLLKQYTSACKTIEDALRLSAHLETNDVSSMLTFDSNAFLAN----VTSF-G-DY
HKU8 -----V---RGEPPAISM-GNISVPSNFTVSIQVEYLOMSIRPVSIDCAMYVCNGNPHCTRLLQYYSACRTIEEALQLSARLESFEVNSMLTVSETALDLVN----ISTF-GDY
Ferret-CoV -----S---EN-PVQPIST-GNVTIPSNFTISVQVEYLOMSSEAVSIDCAQYVCNGNPRCNRLLAQYYSACHAIEALITSTRLEALELESMSISIDNALALAT----VETFNSSDY
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HKU10 -----Y---QPAPVSPITAT-TNISIPLNFTTISIQTVEYIQMYSQQVSVDCSMYVCNGNVRCLRLLTQYATACRNIESALQLSARLESLEVSSVSVSENALKLAN----ITHF-D-SY
BtRf-AlphaCoV -----T---EPEPVAPITT-GNLSIPSNFTVSVQVEYLOMYNKPVSVDCTYVCNGNPRCLKLLTQYATACRTIEEALQLSARLESVEVANMIAVSDEAVQLAN----VSYF-D-TY
LuchengRn-CoV -----I---FIQTH-DTDYARPILTAQOIELPIDHYVSVKEQFIQTSTPKFDVDCERYICDVSSDCRELLVKYGGYCSKILADIKSSSIQLDYQILGLYKTLAVDFKV----PDI---DFGDF
Mink-CoV -----T---NG-DVQPIST-GNVTIPSNFTISVQMEYVQVSTELVSDCARYVCNGNARCGRLLSQYVSACQTI EQALAMGSRLESMELESMSISISENALKLAN----VEEFNSSAM
Bat-CoV-1A -----D---T-FVPSAVIS-GNITIPANFSFVQPEYIQTIMTKPVSVDCAQYVCNGNPRCLQLLTQYASVCRVTEEPLQLNARLEALELTSMIIVQDKTLKLGV----ASNFN-DTF
BtMr-AlphaCoV -----A---AADPVSPVIS-GNISVPTNFTFSVQVEYIQLMLKPVTVDCSVYVCNGNPRCLQLLAQYASACRTIEEQALQLSARLESVEVNSMISISIQEALALGV----IDNFK-HDF
BtNv-AlphaCoV -----V---STTPATPITT-GNLTIPVNFTVSIQAEYVQVSLRAVVVDCAITYVCNGNVRCLQLLRQYVTAQTSVENALALNARLESQEVADMLAVDYAAYRSSLLEN-TPQFE-NGF
Porcine-EDV -----G---QVK-IAPTVT-GNISIPTNFSMSIRTEYLLQYNTPVSVDCATYVCNGNSRCKQLLTQYTAACKTIESALQLSARLESVEVNSMLTISEEALQLAT----ISSFNGDGY
BtCoV512 -----A---QPQ-VQPMFQ-GNISIPTNFTMSVRTEYIQLFNKPVSVDCAMYVCNGNDRCKQLLSQYTSACKNIESALQLSARLESMEVNSMLTVSDEALKLAT----ISQFPGGGY
HKU2 -----M---TFEKH-DTTYVAVPTNERFTELPLDHQLVLTEQFLOTTMPKFSISCEYICDVSKACKNLLFRYGGFCQKIEADIRGAGVLLDSVDSGLYSTIAAKTSS----ITP---TTDRF
NL63-related -----T---TPQVVAPIVT-ANISIPLNFTTISVQVEYLOLSSRPVSDCAYVCNGNPRCLLLTQYSSACKTAEALQLTARLEASEVNSMIKLSPTAIDNANKLGVSTYQ-G-GF
FCoV -----S---DG-DVQPIST-GNVTIPSNFTISVQVEYMQVYTTTPVSDCARYVCNGNPRCNKLLTQYVSACQTI EQALAMGARLENMEVDSMLFVSENALKLAN----VEAFNSSTEN
TGE -----S---DG-DVQPIST-GNVTIPSNFTISVQVEYIQVYTTTPVSDCSRYVCNGNPRCNKLLTQYVSACQTI EQALAMGARLENMEVDSMLFVSENALKLAN----VEAFNSSET

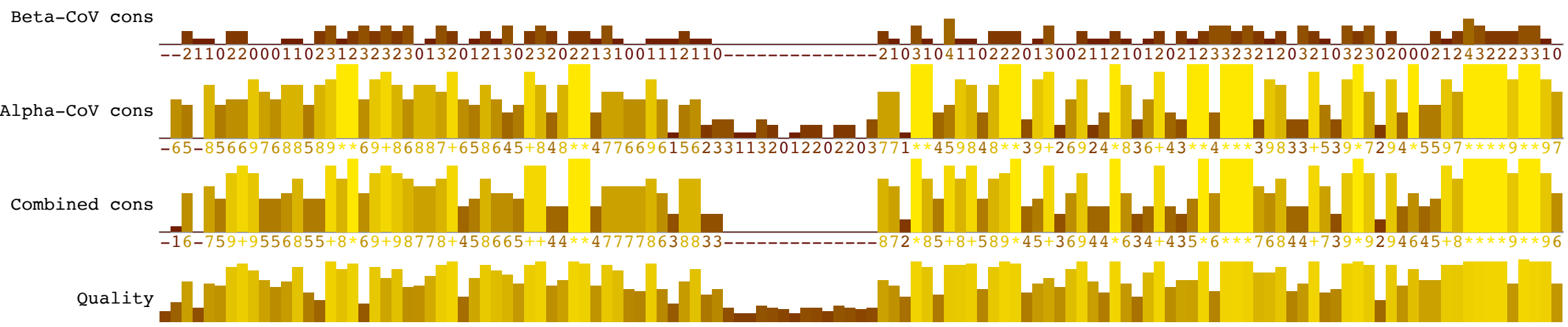
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Covid-19 SQ----SIIAYTMS---LGAENSVAYSNNISIAIPTNFTISVTTEILPVSMTKTSVDCCTMYICGDSTECNSLLQYGSFCTQLNRALTGIAVEQDKNTQEVFAQVKQIYKTP---PIK---DFGGF
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SARS-CoV QK----SIVAYTMS---LGADSSIAYSNNTIAIPTNFTSISITTEVMPVSMAKTSVDCNMYICGDSTECANLLQYGSFCTQLNRALSGIAEQDRNTREVFAQVKQMYKTP---TLK---YFGGF
HKU24 TG----YRLTNFEPFVPTLVNSVESVGGLEYEIQIPTEFTIGNLEEFVQYTTSPKVTIDCAAFVCGDYAACREQLVYDYGFCNDNINAILNEVNSMIDTSQYQLASTLMNGVTLSSRLKDGISFNQDDI
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MHV GYFVODDGEWKFTGSSYYYPEPITDKNSVIMSSCAVNYTKAPEVFLNTSIPNPPDFKEELDKWFKNOTSIAPDLSLDFEKLNVTLTLLDLYEMNRIODAIKKNLSEYINLKEVGTYEMVYVWVYVWL



| | 1280 | 1290 | 1300 | 1310 | 1320 | 1330 | 1340 | 1350 | 1360 | 1370 | 1380 | 1390 |
|---------------|--|---------|--------------|---------|-------|--------------|--------------|----------------|--------------|-----------------|---------------|-------------------------------|
| 229E | ----- | NLSSVI | PSL | PRSGSR | ----- | VAGRSAIEDILF | SKLVTSGLGTVD | ADYKKCTKGLS | ----- | IADLCAQYYNGIMV | LPGVADAERMAMY | TGSLIGGIALGGLT |
| NL63 | ----- | NLSSVL | PQR | NIRSSR | ----- | IAGRSAEDLLF | SKVVTSGLGTVD | VYKSCTKGLS | ----- | IADLCAQYYNGIMV | LPGVADAERMAMY | TGSLIGGMVLGGLT |
| HKU8 | ----- | NLTALL | PQG | -G- | ----- | GKRSVIEDILF | DKVVTSGLGTVD | EDYKRCNTGIG | ----- | IADVCAQYYNGIMV | LPGVVDEEKMIY | TASLLGGMTGGFT |
| Ferret-CoV | LDPVYNDQHNTIGGIYMDGLKDLL | PRR | ----- | SCANKH | ----- | GTCRSVIEELLF | NKVVTSGLGTVD | EYKRCNTGLD | ----- | IADLVCAQYYNGIMV | LPGVVNAKLMYS | SASLGGITLGALG |
| CDPHE15 | ----- | NFTNLM | GTT | ----- | ----- | YSTKSVVEDILF | DKVVTSGLGTVD | ADYKACSNGLS | ----- | IADLVCAQYYQGV | MVLPGVVDAAKL | HMYSASLMGGMALGGVT |
| HKU10 | ----- | NLSVLL | PKS | -D- | ----- | -G-KSVVEDILF | DKVVTSGLGTVD | QDYKNCVKG | LVAQDIADVGC | AQYYNGIMVLP | GVVNEAKMGLY | TASLTGAMVMGGFT |
| BtRf-AlphaCoV | ----- | NVSVLL | PRG | -Q- | ----- | SRGSVIEDLLF | NKVIITSGLGT | VDYKACTGD | -GFGAALADLF | CAQYYNGIMVLP | GVVDETCKMGLY | TASLTGAMVMGGFT |
| LuchengRn-CoV | ----- | NFSMYM | ----- | SE | ----- | ANGRSFIEDLLF | DKIVTTGPGFYQ | -DYDCKKM | ----- | NLQDLTCKQYYN | GIMVIPPVMDDT | LITFWSSAVAGSMTAGLFG |
| Mink-CoV | LNPIYNESGNTIGGIYLDGLKDIL | PRK | ----- | NKH | ----- | GSSRSTIEDLLF | NKVVTGLGTVD | EYKRCCTKGS | ----- | IADLCAQYYNGIMV | LPGVANDGKMS | MYTASLSGGISLGALG |
| Bat-CoV-1A | ----- | DLTLAL | PRQ | ----- | ----- | HQSRSAIEDLLF | SKIVTSGLGT | VDDYKECAAKM | --ANTIAEAGCV | QYYNGIMVLP | GVVDPSSL | SQYTAALTGAMVLGGVT |
| BtMr-AlphaCoV | ----- | NLTNVL | PAS | ----- | ----- | VGAKSAVEDLLF | DKVVTSGLGT | VDADYKECASRT | --ANTVAEVGC | VQYYNGIMVLP | GVVDSLLAQ | YSAALTGAMVFGGVT |
| BtNv-AlphaCoV | ----- | NISAVL | PAG | ----- | ----- | EGKGSFIEDLLF | DKVITNGLGT | VDADYKRCIEEK | ---GAIADVVC | RQYYKGISVLP | PALTDPARMGLY | SASLMGALTLGAFG |
| Porcine-EDV | ----- | NFTNVL | GASVYDPASGRV | ----- | ----- | VQKRSVIEDLLF | NKVVTNGLGT | VDYKRCNSGRS | ----- | VADLVCAQYYSG | VMVLPGVVDAE | KLHMYSASLIGGMALGGIT |
| BtCoV512 | ----- | NFTNIL | PAN | ----- | ----- | PGARSVIEDILF | DKVVTSGLGT | VDYKRCNSGLS | ----- | IADLCAQHYNGIMV | LPGVADWEK | VHMYSASLVGGMTLGGIT |
| HKU2 | ----- | NVSQFFL | PKV | -QSNSER | ----- | FESRSVIEDLLF | SKIETTGP | PGFYG-DYYNCKKN | ----- | AIQDLTCAQYH | NGILVIPPVMD | AETLGMYGGAIAASLTLGIFG |
| NL63-related | ----- | NLTSVV | PQT | -PASTSG | ----- | SFRGSFIEDLLF | NKVIITSGLGT | VDADYKCTKGLS | ----- | IADLCAQYYNGIMV | LPGVVDAEK | MAMYTASLTGAMVMGGLS |
| FCoV | LDPIYKEW-PSIGGSWLGGLKDIL | PSH | ----- | NSK | ----- | RKYGSAIEDLLF | DKVVTSGLGT | VDYKRCCTGGYD | ----- | IADLVCAQYYNGIMV | LPGVANADK | MTYTASLAGGITLGALG |
| TGE | LDPIYKEW-PNIGGSWLEGLKYIL | PSH | ----- | NSK | ----- | RKYRSAIEDLLF | DKVVTSGLGT | VDYKRCCTGGYD | ----- | IADLVCAQYYNGIMV | LPGVANADK | MTYTASLAGGITLGALG |
| OC43 | ----- | NFSPVL | GCL | -GSECSK | ----- | ASSRSAIEDLLF | DKVKLSDVGF | VVEAYNNCTGG | ----- | AEIRDLCVQSY | KGIKVLPLL | SENQISGYTLAATSASLFPFWT |
| MERS-CoV | ----- | NLT-LL | EPV | -SISTGS | ----- | RSARSAIEDLLF | DKVTIADPG | YMQ-GYDDCMQ | -G-PASARDL | CAQYVAGYK | VLPPLMDVN | MEEAAYTSSLLGSIAGVGTAG |
| HKU1 | ----- | NFKSLV | GCL | -GPHCGS | ----- | SSRSFFEDLLF | DKVKLSDVGF | VVEAYNNCTGG | ----- | SEIRDLLCVQ | SFNGIKVLP | PILESQISGYTTAATVAAMFPWS |
| Covid-19 | ----- | NFSQIL | PDP | -S--K | ----- | PSKRSFIEDLLF | NKVTLADAG | FIK-QYGDCLG | ----- | IAARDLCAQK | FNGLTVLP | PLLTDDEMIAQYTSALLAGTITSGWTFG |
| Bovine-CoV | ----- | NFSPVL | GCL | -GSDCNK | ----- | VSSRSAIEDLLF | SKVKLSDVGF | VVEAYNNCTGG | ----- | AEIRDLCVQSY | NGIKVLPPLL | SENQISGYTLAATSASLFPWS |
| HKU4 | ----- | NLT-LL | QVP | -QIGSS | ----- | SSYRSAIEDLLF | DKVTIADPG | YMQ-GYDDCMQ | -G-PQSARDL | CAQYVSGYK | VLPPLYDPN | MEEAAYTSSLLGSIAGAGWTAG |
| HKU5 | ----- | NLT-ML | QIP | -QVTTGE | ----- | RKYRSTIEDLLF | NKVTIADPG | YMQ-GYDECMQ | -G-PQSARDL | CAQYVAGYK | VLPPLYDPY | MEEAAYTSSLLGSIAGASWTAG |
| HKU9 | ----- | NFTGLM | GCL | -GPNCGA | ----- | TTYRSAFSDLLY | DKVRITDPG | FMQ-SYQKIDSQ | -GGSIRDLL | CTQTYNGIA | VLPPIVSPAM | QALYTSLLVGAVASSGYTFG |
| SARS-CoV | ----- | NFSQIL | PDP | -L--K | ----- | PTKRSFIEDLLF | NKVTLADAG | FMK-QYGECLG | ----- | INARDLCAQK | FNGLTVLP | PLLTDDEMIAAAYTAALVSGTATAGWTFG |
| HKU24 | ----- | NFSSVM | GCV | -GSNCI | ----- | SHRSAIEDILF | NKVKLSDVGF | VVEAYNNCTGG | ----- | SEIRDLCVQSF | NGIKVLPV | LVSESQMSQISGYTAGATASAMFPWS |
| Rat-CoV | ----- | NFSPLL | GCL | -GSYCSE | ----- | GTMVQGRSAIED | VLFDKVKLS | DVGFVEAYNNCTGG | ----- | QEVDRLLCVQ | SFNGIKVLP | PPVLSSESQMSQISGYTAGATASAMFPWS |
| Bat-BCoV | ----- | NFSSIL | NQE | -AINGNN | ----- | FQARSAIEDLFF | DKIETADV | GFQK-KYDECTGG | ----- | SVVKDLGCAQ | SFNGLMVL | PPQMTDAHVAAYTTSAA----- |
| Hedgehog-CoV | ----- | NLS-LF | EAP | -NIGSGN | ----- | NNYRSALEDLLF | DKVTLSDP | GYMK-GYDECMK | -G-PPSARDL | CAQYVSGYK | VLPPLYDAN | MEAMYTASLTGSIAGSFWTGG |
| GCCDC1 | ----- | NFSGLM | GCL | -GSNCQE | ----- | KQYRSAISDLLY | NKVKVADP | GFMG-AYQKIDEQ | -GGSVRDL | ICTQTFNGI | SVLPPIVSP | GMQALYTSLLVGAVASSGYTFG |
| HKU14 | ----- | NFSPVL | GCL | -GSDCNK | ----- | ASSRSAIEDLLF | DKVKLADV | GFVEAYNNCTGG | ----- | AEIRDLCVQSY | NGIKVLPPLL | SENQISGYTLAATSASLFPFWT |
| MHV | LIGLAGVAVCVLLFFICCTGCGSCCFKCKGNCCDEYGGHODSIVIHNISSED | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |

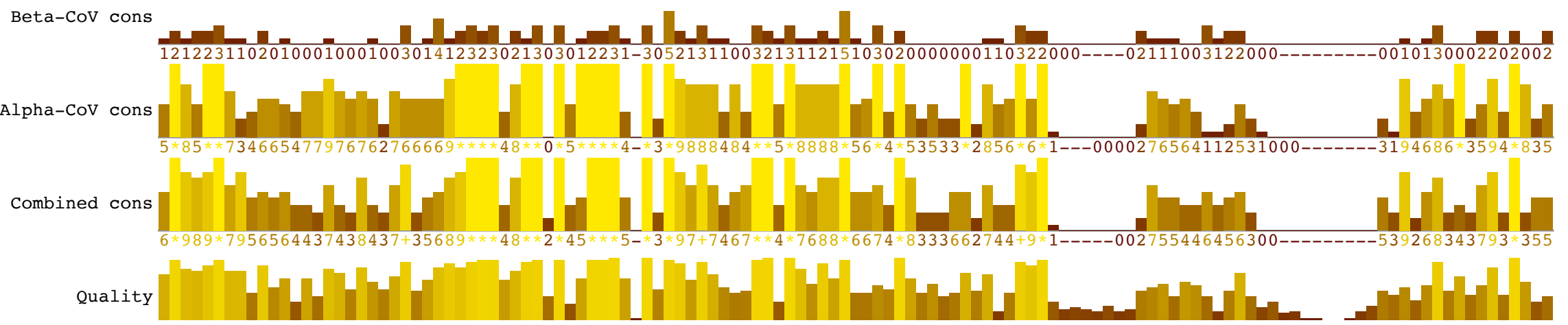


| | 1400 | 1410 | 1420 | 1430 | 1440 | 1450 | 1460 | 1470 | 1480 | 1490 | 1500 | 1510 | 1520 | |
|---------------|----------------|---------------|---------------|--------------|---------------|--------------|--------------|-------------|-------------|------------|---------------|---------------|--------------|--------|
| 229E | -SA-ASIPFSLAIQ | SRLNYVALQTDV | LQENQKILAASF | NKAMTNIVDAFT | GVNDAITQTSQAL | QTVATALNKIQD | VVNQOGNSLNHL | TSQLRQNFQAI | SSSIQAIYDR | LDIIQADQ | QVDR | LITGRLA | | |
| NL63 | -SA-AAIPFSLALQ | ARLNYVALQTDV | LQENQKILAASF | NKAINNIVASF | SSVNDAITQTAE | AIHVTIANKIQD | VVNQOGSALNHL | TSQLRHNFOAI | SNSIQAIYDR | LDISIQADQ | QVDR | LITGRLA | | |
| HKU8 | -PV-AALPFALSVQ | SRLNYVALQTDV | LQKNQKILANAF | NSAIGNITVAFD | QVTTAVQOTSDA | IKTVAASALNK | VQSVVNSQOQAL | HQLTKQLASNF | QAISSASIED | IYNRLDGLA | ADANVDR | LITGRLA | | |
| Ferret-CoV | -GGLVSVPFATAV | QARLNYVALQTDV | LQENQKILAASF | NQAIGNITLAF | GKVNSAIQTAQ | GLSTVAQALTK | VQDVVNSQOQAL | NHLTAQLQNNF | QAISSSIEDI | IYKLDQNTA | DADAQVDR | LITGRLA | | |
| CDPHE15 | -AA-AALPFASYAV | QARLNYVALQTDV | LQRNQKILAASF | NNAIGNITNAF | ASVNDASISQTA | EGLSTVAEALSK | VQDVVNNQGMAL | NHLTLQLQNNF | QAISSSIADI | IYRRLDQV | LTDADAQVDR | LINGRLA | | |
| HKU10 | -AA-AAIPFSLAVQ | SRLNYVALQTDV | LQONQKLLADSF | NNALSNITLAF | SNVNDALQDASE | AINTVAVALKVQ | GVVNEQGOAIAH | LTLQQLTQNFQ | AISSHSIADI | IYNRLDELA | ADAQTDRL | LITGRIS | | |
| BtRf-AlphaCoV | -AA-AAIPFSLAVQ | SRLNYVALQTDV | LQENQKILASAF | NAMSNIYAFTE | VKNAIKDTSVAI | STVAQALGKIQ | NVVNDQGOALS | QLTRQLASNF | QAISSSIQDI | IYNRLNDVE | ADAQVDR | LITGRLA | | |
| LuchengRn-CoV | -GQAGMVSWTVAL | AGRLNALGVMQD | ALVEDVNKLANG | FNNTQYVSDG | FKT----- | TSQALSTIQAV | VNNNAQOVSQ | LVQGLSENF | GAISSNFAL | IAERLERIE | AAMQMDRL | INGRMN | | |
| Mink-CoV | -GGAVAIIPFSLAV | QARLNYVALQTDV | LQRNQEILAASF | NQAIGNITIAL | GKVNNAIYQTS | QSLSTVAQALTK | VQDVVNSQOQAL | NHLTLQLQNNF | QAISSSIQDI | IYKLD | DDINADAQVDR | LITGRLA | | |
| Bat-CoV-1A | -AA-AAIPFSLAVQ | ARLNYLACQTDV | LQRNQMILAQSF | NAAMGNITVAF | SGVSNAIQOTA | QSLNTISQALNK | VENVVNEQGTAL | SQTKQLASNF | QAISSSIEDL | YNRLDTLEAD | QVDR | LITGRLA | | |
| BtMr-AlphaCoV | -AG-AAVPFSIAVQ | SRLNYLALQTDV | LQRNQQLANSF | NAAMGNITEAF | GRVNDALIEQT | SHAISTVAQAL | DKVQTVVNDQ | GLALSQTKQL | ASNFQAISSS | IEDL | YNRLDRVEAD | LQVDR | LITGRLA | |
| BtNv-AlphaCoV | -GGAVAIPFSAVQ | ARLNYLALQTDL | IQENQKLI | SAAFNNAMGNIT | KAFTDVNTAL | QHVSDAVKTV | ATALNKVQDAV | NTQGEALQKLT | SQLAQNFD | AISSSIDDI | YNKLDVLA | ADAQVDR | LINGRLS | |
| Porcine-EDV | -AA-AALPFSYAVQ | ARLNYLALQTDV | LQRNQQLLAESF | NQAIGNITSAF | ESVKEAISQTS | KGLNTVAHALTK | VQEVVNSQOQAL | NQLTVQLQHN | FQAISSSIDDI | YSRLDILS | ADVQVDR | LITGRLS | | |
| BtCoV512 | -SA-AALPFSYAVQ | ARLNYVALQTDV | LQRNQMLANSF | NAISNITLAF | ESVNNAIYQTS | AGLNTVAEALSK | VQDVVNGQGNAL | SQTLVQLQNNF | QAISSSIGDI | YSRLDQIT | ADAQVDR | LITGRLA | | |
| HKU2 | -GQAGITTWSLAM | AGRLNALGVVQ | NALVDDVNKLANG | FNQLTASVGK | LALT----- | TSSALQAIQAV | VNNAQOQVES | LVSGITENF | GAISSSTNF | KVISQRLDK | LEADVQMDRL | INGRMN | | |
| NL63-related | -AA-ASIPFSLAVQ | SRLNYVALQTDV | LQENQKILAASF | NKAIGSITQAF | TEVNDALIAQTS | QAIGTVAGALNK | IQGVVNEQOQAL | SHLTKQLQNNF | QAISSSIEDI | YNRLDSL | AADAQVDR | LITGRLA | | |
| FCoV | -GGAVAIIPFAVAV | QARLNYVALQTDV | LKNQKILANAF | NQAIGNITQAF | GKVNDAIHQTS | QGLATVAKAL | AKVQDVVNTQ | GOALSHLTVQ | LQNNFQAI | SSSISDI | YNRLDEL | SADAQVDR | LITGRIT | |
| TGE | -GGAVAIIPFAVAV | QARLNYVALQTDV | LKNQOILASAF | NQAIGNITOSF | GKVNDAIHOTS | SRGLATVAKAL | AKVQDVVNI | OQOALSHLTVQ | LQNNFQAI | SSSISDI | YNRLDEL | SADAQVDR | LITGRIT | |
| OC43 | --AAAGVPFYLNV | QYRINGLGVTMD | VLSQKLIANAF | NNALYAIQEG | FDA----- | TNSALVKIQAV | VNANA | EALNNLLQQL | SNRFGAISAS | LQEILSRLD | ALEAEAQIDRL | INGRLT | | |
| MERS-CoV | LSSFAAIPFAQS | IFYRLNGVGITQ | QVLSNQKLIANK | FNQALGAMQT | GFTT----- | TNEAFQKVQD | AVNNAQALSK | LASELSNTF | GAISSIGDI | IQR | LDVLEQDAQIDRL | INGRLT | | |
| HKU1 | --AAAGIPFSLNV | QYRINGLGVTMD | VLNKNQKLIATA | FNNALLSIQNG | FSA----- | TNSALAKIQS | VVNSNAQAL | NLLQQLFNK | FGAISSLQ | EILSRLD | ALEAQVQIDRL | INGRLT | | |
| Covid-19 | AGAALQIPFAMQ | MAYRFNGIGVT | QNVLYENQKLI | ANQFN | SAIGKIQDSL | SS----- | TASALGKLD | VVNQNAQAL | NLTVKQLSS | NFGAISSV | LNDILSRLD | KVEAEVQIDRL | ITGRLQ | |
| Bovine-CoV | --AAAGVPFYLNV | QYRINGIGVTMD | VLSQKLIANAF | NNALGAIQEG | FDA----- | TNSALVKIQAV | VNANA | EALNNLLQQL | SNRFGAISS | LQEILSRLD | ALEAQVQIDRL | INGRLT | | |
| HKU4 | LSSFAAIPFAQS | MFYRLNGVGIT | QVLSNQKLIANK | FNQALGAMQT | GFTT----- | SNLAFSKVQ | DAVNANAQAL | SKLASELS | NTFGAISS | ISDILAR | LDTVEQDAQIDRL | INGRLI | | |
| HKU5 | LSSFAAIPFAQS | IFYRLNGVGIT | QVLSNQKI | IANKFNQALG | AMQTGF | TT----- | TNLAFNKVQ | DAVNANAMAL | SKLAAEL | SNTFGAISS | ISDILAR | LDTVEQEAQIDRL | INGRLT | |
| HKU9 | ITSAGVIPFATQ | LQFRLNGIGVT | TQVLVENQKLI | ASSFNNALVNI | QKGFTE----- | TSIALSKMQD | VINQHA | AQLHTLVVQ | LGNSFGAI | SSSINEIF | SRLEGLAANA | EVDR | INGRMM | |
| SARS-CoV | AGAALQIPFAMQ | MAYRFNGIGVT | QNVLYENQKLI | ANQFNKAI | SQIQESL | TT----- | TSTALGKLD | VVNQNAQAL | NLTVKQLSS | NFGAISSV | LNDILSRLD | KVEAEVQIDRL | ITGRLQ | |
| HKU24 | --AAAGVPFTMSV | QYRINGLGVTMD | VLNQKMIANAF | NNALTAIQNG | FDA----- | TNSALAKIQS | VVNSNAEAL | NNLLQQLSN | RFGAISSL | QEILSRLD | ALEAQVQIDRL | INGRLT | | |
| Rat-CoV | --AAAGVPFALSV | QYRINGLGVTM | NVLSQKMIANAF | NNALTAIQNG | FDA----- | TNSALAKIQS | VVNSNAEAL | NNLLQQLSN | RFGAISSL | QEILSRLD | ALEAQVQIDRL | INGRLT | | |
| Bat-BCoV | LGSFFSIPNTMQ | MAYRFNGIAVT | QKVLVDNQKLI | ANKFNQAMMS | VQTGFKA----- | TSSALEKQK | VVNDNAQAL | NNLVAQLT | NNFGAISS | AINDI | ITQRLDKLE | ADAQIDRL | INGRLQ | |
| Hedgehog-CoV | LSSAAALPFAQ | SMFYRMNGIGIT | QNVLMKNQRE | IANKFNQALG | AMQTGF | TA----- | TNQAFQKVQ | DVVNANAQAL | SKLASEL | ANTFGAISS | IGDILKRLD | VLEQEVQIDRL | INGRLT | |
| GCCDC1 | ITSVGVIPFATQ | LQFRLNGLGVT | TNVLMENQKLI | ANAFNNAL | TGIQKGF | DA----- | TNMALAKMQ | SVINQHA | QQLSTL | VQDQLGNS | FGAISSS | INEIFSR | LDELEANAQVDR | INGRMV |
| HKU14 | --AAAGVPFYLNV | QFRINGLGVTMD | VLSQKLIANAF | NNALDAIQEG | FDA----- | TNSALAKIQAV | VNANA | EALNNLLQQL | SNRFGAISS | LQEILSRLD | ALEAAAQIDRL | INGRLT | | |
| MHV | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | |

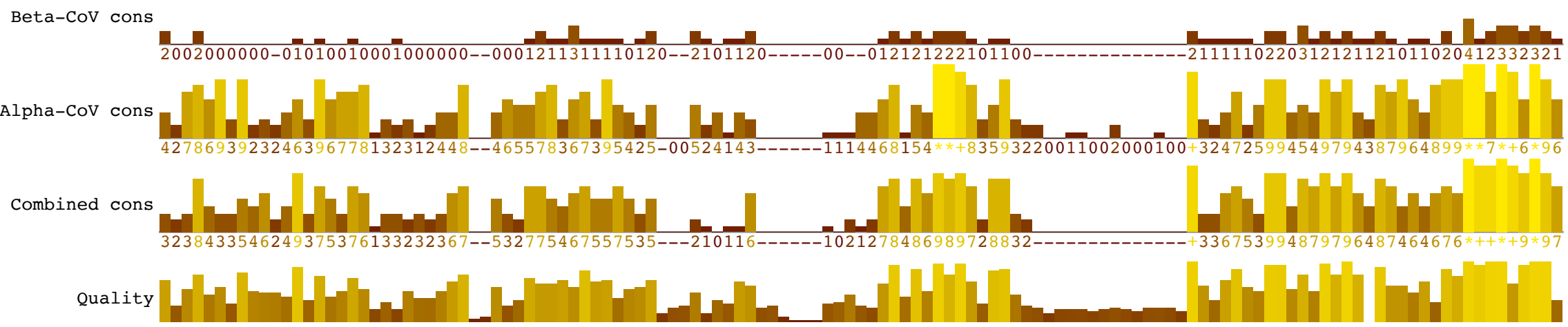


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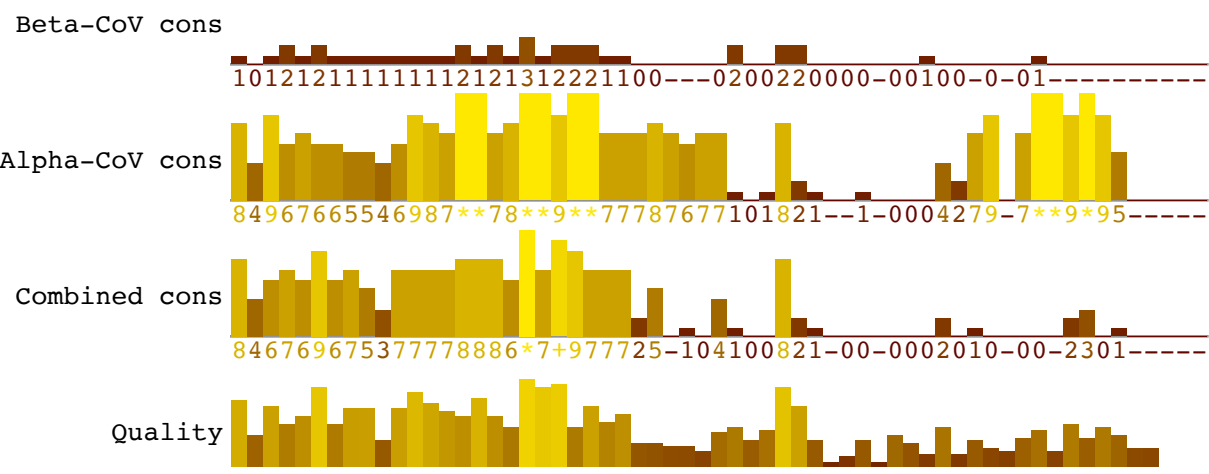
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NL63 ALNAFVSVLTKYTEVGRSRLAQQKINECVKSQSNRYGFCGN-GTHIFSIIVNSAPDGLLFLHTVLLPTDYKNVKAWSGICV---DGIYGYVLRQPNLVLYSDN-----GVFVTSRVMFQPRLP
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MHV -----



| | 1660 | 1670 | 1680 | 1690 | 1700 | 1710 | 1720 | 1730 | 1740 | 1750 | 1760 | 1770 | |
|---------------|--------------------|----------|----------------------|-------------------|----------------------|------------------|----------------|---------|-------------|--------------|--------------|-------------|-----|
| 229E | TIADFVQIENCNVTFVNI | SRSELQTI | VP--EYIDVNKTLQEL | SYK-LPNY | TVPD-----LVVEQYNQ | TILNLTSE | ISTLENKSAELNY | TVQKLQ | TLIDNIN | STLVDLK | WLNRVET | YIKWP | |
| NL63 | VLSDFVQIYNCNVTFVNI | SRVELHT | VIP--DYVDVNKTLQE | FAQN-LPKY | VKPN-----FDLTPFN | LTYNLSSSELK | QLEAKTASL | FQTTVEL | QGLIDQ | INSTYVD | LKLLNRF | FENYIK | |
| HKU8 | TSADFIRISGCNVVYVNI | TDEQLPQ | VQPF--EFIDVNKTL | EELMSR-LPN | NTGPN-----LPLDIFN | QTYLNISAEI | DALENKSL | EQATADK | QLTIEQ | LNATLV | DLEWLN | RFEQYV | |
| Ferret-CoV | TMSDFVQIESCTTTFV | NATVAEL | PSIIP--DYIDINGT | IKDMLDQY | KPNWTVPE-----LTIDVF | NATYLNLTSE | INEALEN | SVILQOT | VLELES | LIDNIN | STLVNLE | WLNRVET | |
| CDPHE15 | QISDFVRIEGCDVEYF | NVTGESL | PDIFP--DFIDVNKTL | EDILSQ-LQN | NTGPK-----FDIDFN | NATYLNLSSE | IADELMR | SESLHNT | TEELK | RLIDNIN | STLV | DLEWLN | |
| HKU10 | QFSDFVQVENCVVS | YLNLS | SDVDVNT | VIP--DYIDVNKTL | EDLLQ-LPN | HTLDP-----LGLDQY | NNIILNLT | AEIDIL | QNKSD | LLAS | TERLQ | QLIDN | |
| BtRf-AlphaCoV | QESDFVRITGCSV | YVYLN | NITHTQ | IGDIIP--EYIDVNKTL | EEFLNS-YP | NYTVPD-----LNL | LDLYNQ | TVLNL | TEDISK | LKYE | KAESL | HNKTI | |
| LuchengRn-CoV | TVNNTLTISG-GVN | FTVNST | IDGIEP | --ANPSFDEE | FAELYKNV--TLE | LEQLKN-----ISF | DEPEML | NLTY | YIDR-----L | DELAT | NVSQ | LHVDV | |
| Mink-CoV | TSADFVQIADCDV | LFNATIL | ELPSIIP--DYIDINK | TVDLLDSY | KPNWTVPE-----LSLD | IFNQTYLN | ITNEIN | DLENRS | VVLYNT | TKELLE | LIQS | INNTL | |
| Bat-CoV-1A | VSADFVEVSSCN | VTFINLT | INELPELLP--DYIDVNKTL | KFAAT-IP | NRTEMQ-----LTL | NTYNATV | LNLTDE | VKSLMS | QADDL | TKIAS | ELNLT | ISKIN | |
| BtMr-AlphaCoV | QTSDFVQITGCDV | VYLVN | TRDELPT | VIP--DYIDVNST | VEDILSK-LP | NRTPPE-----FDLD | IFNATY | LNLTGE | IADLT | ARSESL | KNTTLE | LELKE | |
| BtNv-AlphaCoV | QMSDFVQIQSCA | ITYVNL | TSEEFNS | VP--DYIDVNKTL | EDFAAT-LP | NRTPPE-----FSL | DQFNHT | YLNISG | QISVLE | NKSAE | LLITER | LQHIQ | |
| Porcine-EDV | TVSDFVQIESCV | VTYVNL | TSQLPD | VIP--DYIDVNKTL | DEILAS-LP | NRTPPE-----LPL | DVFNA | TYLNLT | GEIAD | LEQRSE | SLRNTT | TEELR | |
| BtCoV512 | EVADFVQVKTCTI | SYVNIT | TNNQLP | DIIP--DYVDVNK | TIDEILAN-LP | NTVDP-----LPL | DVFNQ | TFLNLT | GEIAD | LEARSE | SLKNTS | EELRQ | |
| HKU2 | TFANVIAVSR-GAN | YTTLN | RTFDIP | ELN--STFPID | EDEFREY | FQNM--SSEL | QALKN-----LTAD | MSKLN | ISAEI | QL-----I | NEIAH | VSNM | |
| NL63-related | EISDFIQISNCDV | QFLNLT | QDQVD | IP--EYVDVNKTL | EEALSK-LP | NYTKPD-----L | SLDVF | NQTYLN | LSSEI | DQLEQ | KAESL | TNTTI | |
| FCoV | TSSDFVQIEGCDV | LFNATV | IDLPSIIP--DYIDIN | QTVODIL | ENFRPNWTVPE-----FTLD | IFNATY | LNLTGE | IDDLE | FRSEK | LHNTT | VELAIL | IDNIN | |
| TGE | TSSDFVOIEGCDV | LFNATV | SDLPSIIP--DYIDIN | QTVODIL | ENFRPNWTVPE-----L | TFDIF | NATYLN | LTGEI | DDLE | FRSEK | LHNTT | VELAIL | |
| OC43 | TENNVMSTCAVNY | TKAPY | VMLNTSIP--NLP | DFKEELD | QWFKNQ--TSV | APDLS----LD--Y | INVTFL | DLQ | DEMNR-----L | QEAIK | VLNQ | SYINL | |
| MERS-CoV | TSLNTKYVAP-QV | TYQNI | STNLPP | PLLGNSTG | IDFQDEL | DEFFKNV--ST | SIPNF----G | SLTQ | INTTLL | DLTYE | MLS-----L | QOVV | |
| HKU1 | SDKNVVMNTCSV | NFTKAP | LVYLNH | SVP--KLSDFE | SELSHW | FKNQ--TSI | APNLT---L | NLHTI | NATFL | DLYE | MNL-----I | QESIK | |
| Covid-19 | TTDNTFVSGN | CDVVIGI | VNNTVY | DPLQP--ELDS | FKEELD | KYFKNH-----T | SPDVL | GDISG | INASV | VNIQ | KEIDR-----L | NEVA | |
| Bovine-CoV | TGNNVMSTCAVNY | TKAPD | VMLNISTP--NLP | YFKEELD | QWFKNQ--TSV | APDLS----LD--Y | INVTFL | DLQ | DEMNR-----L | QEAIK | VLNQ | SYINL | |
| HKU4 | TQANSRYVSS-DV | KFDKLE | NNLPP | PLENSTD | VDFKDE | LEEFFKNV--T | SHGPNF--- | AEISK | INTTLL | DLSD | EMAM-----L | QEVV | |
| HKU5 | TEANSKYVSM-DV | KFENLT | NRLPP | PLLSNST | DLDFKEE | LEEFFKNV--S | SQPNF--- | QEISK | INTTLL | NLNT | ELMV-----L | SEVV | |
| HKU9 | SASNTQVLTSC | SVNYTS | VNYTVLE | PSVP--GDYDF | QKEF | DKFYKNL--ST | IFNNTF--- | NPND | FNSTV | DVTAQ | IKS-----L | HDVV | |
| SARS-CoV | TTDNTFVSGN | CDVVIGI | IINNTVY | DPLQP--ELDS | FKEELD | KYFKNH-----T | SPDVL | GDISG | INASV | VNIQ | KEIDR-----L | NEVA | |
| HKU24 | TNDNVIMMNN | CAVNF | TKAPD | VMLNTSIP--NLP | DFKEELD | KWFKNQ--TSI | VPDLS--- | LDL | ERINVT | FLDL | QEMDR-----I | QDAI | |
| Rat-CoV | TDKNSVVMSSCA | VNYTKA | PEVFLNTSIT--NLP | DFKEELD | KWFKNQ--TSI | VPDLS--- | FDIGK | LNVTFL | DL | SYEMNR-----L | QDAI | KLN | |
| Bat-BCoV | TIDNIRSAGS | CNVDTY | VNHTIYN | PEMP--ELED | FQEL | EEIRKNF--ST | GLPNR | PNFTL | PGLE | GINAS | MVDL | SEVKI-----L | NDV |
| Hedgehog-CoV | TSFNRSRVQP-E | FTFQNL | TNNLPP | PLLSNS | SDVTFE | DELEEFYKNI--T | SEIPNF--- | GSIS | QINTT | MLNL | SREMSI-----L | QOVV | |
| GCCDC1 | SVSNTQVLAAC | GLNYSS | VNYTVLE | PAVD--TSS | FNTE | EFEKWYVNO--S | HIFNNTF--- | NASAF | NFSL | VDVNE | QLAI-----L | TDV | |
| HKU14 | TENNVMSTCAVNY | TKAPD | VMLNISTP--NLP | DFKEELD | QWFKNQ--TSV | APDLS----LD--Y | INVTFL | DLQ | DEMNR-----L | QEAIK | VLNQ | SYINL | |
| MHV | ----- | | | | | | | | | | | | |



| | 1780 | 1790 | 1800 | 1810 | 1820 | 1830 |
|---------------|--|------|------|------|------|------|
| 229E | ISVVLIFVVSMLLLCCCSTGCCGFFSCFASSIKGCCE--S-TKLPYYD-VEKIHIO | | | | | |
| NL63 | ISVVFVLLSLLLVFCLSTGCCGCCNCLTSSMRGCCDCGS-TKLPYYE-FEKVHVQ | | | | | |
| HKU8 | MIIALVLLTGLMLWCCLATGCCGCCCMASL---L-DFRG-SRLOQYE-VEKVHIO | | | | | |
| Ferret-CoV | IGLILLIALPMLLFCCCLSTGCCGCCGLTSCLAGCCKNSCKRP-SYYEPMKVVHIN | | | | | |
| CDPHE15 | IAIALIFTVSLLLFCCIATGCCGCCGCASCLTGCC--KG-PRLQPYEAIEKVHVQ | | | | | |
| HKU10 | ILLAILFSLFMLYCCCATGCCGCLSLTNS---C-DCRG-KNLQRYE-VEKVHIO | | | | | |
| BtRf-AlphaCoV | IFLALAAFTFLMYCCCATGCCGCLSCICSS---CADCRG-KRLQRYE-VEKIHIO | | | | | |
| LuchengRn-CoV | IFLVLVLFSLFMLWCCCATGCCGCCGLCGAACNGCCTK-----POPIE-FEKVHVQ | | | | | |
| Mink-CoV | IALIFLFLVLPMLLFCCCLSTGCCGCCGLSSCAAGCKYSCSRDLSRYEPIEKVHVN | | | | | |
| Bat-CoV-1A | IAVTLIILVGPMLWCCCLATGCCGCCSCLVNSCSDCG---G-RRLQRYE-IEKVHVQ | | | | | |
| BtMr-AlphaCoV | IVLVLILFTCLMLFCCCSTGCCGIFSCMASSCGACCDIRG-TKLQRYEAIEKVHVQ | | | | | |
| BtNv-AlphaCoV | FAVVFVILLGLMLWCCCATGCCGCCSCITASCAGCCDCRG-KRLQRYE-VEKIHIO | | | | | |
| Porcine-EDV | IVIVLIFVVSLLLVFCCISTGCCGCCGCCGACFSGCC--RG-PRLQPYEAFEKVHVQ | | | | | |
| BtCoV512 | IVIALILVVSLLLVFCCISTGCCGCCGCCGSCFSGCC--RG-TKLQHYEPIEKVHVQ | | | | | |
| HKU2 | IFIALTLLAGLMLWCCLATGCCGMCGCLAATCASCDCRG-TKLQSYE-IEKIHIO | | | | | |
| NL63-related | IAVVLIFVVSLLMFCCCATGCCGCCSMTSSLRGCCDCGS-TKLPYYE-FEKVHVQ | | | | | |
| FCoV | IGLVVVFICPILLLFCCFSTGCCGICGLSCCHSICS---RRQFENYEPIEKVHVH | | | | | |
| TGE | IGLVVVFICPILLLFCCSTGCCGICGLSCCHSICS---RROFENYEPIEKVHVH | | | | | |
| OC43 | ICLAGVAMLVLLFFICCTGCGTSCFK---KCGGCCDDYT-GYQELVI-KT---SHDD | | | | | |
| MERS-CoV | FIAGLVALALCVFFILCCTGCGTNCMG-KLKCNRCCDRYE-EYDLE-P-HK-VHVH | | | | | |
| HKU1 | ISFSFIIFLVLLFFICCTGCGSACFS---KCHNCCDEYG-GHHDFVI-KT---SHDD | | | | | |
| Covid-19 | FIAGLIAIVMVTIMLCCMTSCCCLKG-CCSCGSCCKFDE-DDSEPVL-KG-VKLHYT | | | | | |
| Bovine-CoV | IGFAGVAMLVLLFFICCTGCGTSCFK---KCGGCCDDYT-GHQELVI-KT---SHED | | | | | |
| HKU4 | FIAGLVALLLCVFFLLCCTGCGTSCLG-KMKCKNCCDSYE-EYDVE-K-IH-VH | | | | | |
| HKU5 | FIAGLVALALCVFFILCCTGCGTSCLG-KLKCNRCCDSYD-EYEVE-K-IH-VH | | | | | |
| HKU9 | MIAGIVGLVLAIVMLMCMTNCCSCFKG-MCDCRRCGSDYD-SYDD-VY-PA-VRVKNKRTV | | | | | |
| SARS-CoV | FIAGLIAIVMVTILLCCMTSCCCLKG-ACSCGSCCKFDE-DDSEPVL-KG-VKLHYT | | | | | |
| HKU24 | IGLAGVAVLVLFFVCCCTGCGSSCFK---KCGSCDDYG-GHQDIVV-KT---SHDD | | | | | |
| Rat-CoV | IGLAGVAVCVLFFICCTGCGSCCFK---KCGNCCDEYG-GRQAGIV-IHNISSED | | | | | |
| Bat-BCoV | FIAGLIAIVMATIMLCCMTSCCSCFKG-LCACKRCCDSFD-EPDEPI-----KYHYP | | | | | |
| Hedgehog-CoV | FIAGLVALALCLFFILCCTGCGTSCLG-KINCTRCCDKYD-DFDMPEK-IH-IH | | | | | |
| GCCDC1 | MIAGLVGLVLAIVLMLMCMTNCCSCARG-VCSCKSCA--YE-EHED-VY-PA-VRVHGKRTA | | | | | |
| HKU14 | IGLAGVAVLVLFFICCTGCGTSCFK---KCGGCCDDYT-GHQELVI-KT---SHDD | | | | | |
| MHV | ----- | | | | | |



Envelope (E) protein

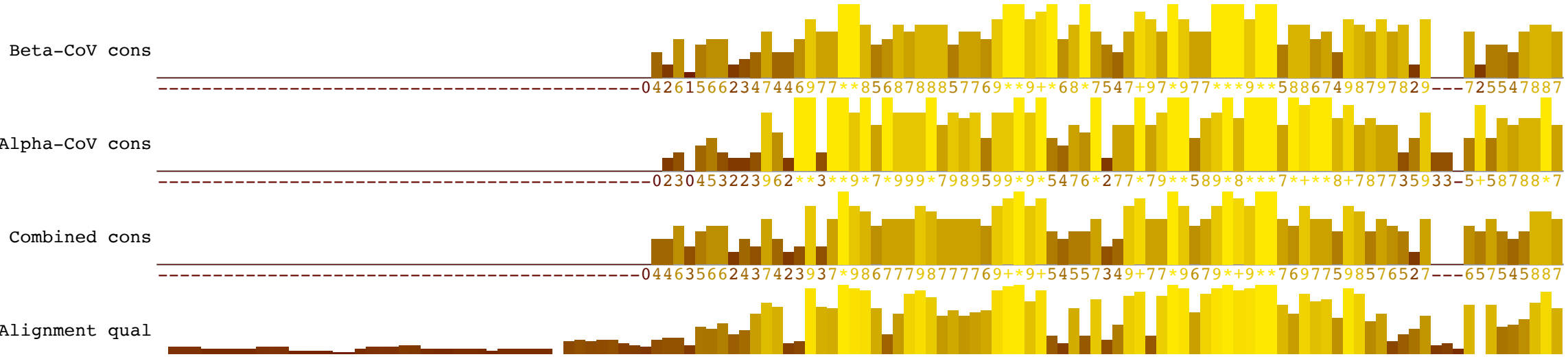
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|-------------------|---|---|----|----|----|----|----|----|----|
| <i>SARS-CoV-2</i> | 1 | --MYSFVSEETGTLIVNSVLLFLAFVVFLLVTLAILTALRLCAYCCNIVNVSLVKPSFYVYSRVKNLNSS--R-VPD---LLV- | | | | | | | |
| <i>SARS-CoV</i> | 1 | --MYSFVSEETGTLIVNSVLLFLAFVVFLLVTLAILTALRLCAYCCNIVNVSLVKPTVYVYSRVKNLNSS--EGVPD---LLV- | | | | | | | |
| <i>HKU1</i> | 1 | --MVDLFFNDTAWYIGQILVLVLFCLISLIFVVAFLATIKLCMQLCGFCNFFIISPSAYVYKRGMQLYKSYSEQVIPPTSDYLI- | | | | | | | |
| <i>OC43</i> | 1 | MFADAYLADTVWYVGQIIFIVAICLLVTIVVVAFLATFKLCIQLCGMCNTLVLSPSIYVFNRGRQFYEFYNDVKP-PVLDVDDV | | | | | | | |
| <i>MERS-CoV</i> | 1 | --MLPFVQERIGLFIVNFFIFTVVCAITLLVCMAFLTATRLCVQCMTGFNTLLVQPALYLYNTGRSVYVKFQDSKPPLPPDEWV- | | | | | | | |
| <i>229E</i> | 1 | --MFLKLV-DDHALIVNVLLWCVVLIVILLVCITIKLIKLCFTCHMFCNRTVYGPVYKIVYHI----YQSYMHIDPFP-KRVIDF | | | | | | | |
| <i>NL63</i> | 1 | --MFLRLI-DDNGIVLNSILWLLVMIFFVFLAMTFIKLIQLCFTCHYFFSRTLYQPVYKIFLA----YQDYMQIAPVP-AEVLNV | | | | | | | |

Membrane (M) Protein

| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
|-------------------|-----|----------|-------------|-------------|-------------|-----------|----------|-----------|-----------|------------------------------|----------|
| <i>SARS-CoV-2</i> | 1 | -----MAD | SNGTITVEELK | KLLEQWNLVIG | FLFLTWICLLQ | FAYANRNRF | LYIIKLI | FLWLLWPV | TLACFVLA | AV--YRINWITGGIAIAM | |
| <i>SARS-CoV</i> | 1 | -----MAD | NGTITVEELK | QLLEQWNLVIG | FLFLAWIMLLQ | FAYSNRNRF | LYIIKLV | FLWLLWPV | TLACFVLA | AV--YRINWVTGGIAIAM | |
| <i>HKU1</i> | 1 | ----MNK | SFLPQFTSDQ | AVTFLKEWNF | SLGVILLFIT | IIILQFGY | TSRSMFVY | LIKMIILW | LWMWPLTIT | LTIFNCF--YALNNAFLA | |
| <i>OC43</i> | 1 | MSSK | TPAPVYIWT | ADEAIKFLKE | WNFSLGIILL | FITIIILQ | FGYTSRSM | FVVIKMIIL | WLMWPLTII | ILTIFNCV--YALNNVYLGLSIVF | |
| <i>MERS-CoV</i> | 1 | -----MS | NMTQLTEAQ | IIAIIKDN | FWAFLIFLL | LITIVLQY | GPSRSM | TVYVFKM | FVLWLLWP | SSMALSIFSAV--YPIDLASQIIISGIV | |
| <i>229E</i> | 1 | -----MS | ND-NCTGD | IVTHLKNW | NFGWNVILT | FIVILQF | GHYKYSR | LFYGLK | MVLWLLW | PLVLALSIFD | TWANWDSN |
| <i>NL63</i> | 1 | -----MS | NSSVPLLE | VYVHLRNW | NFSWNLILT | LFIVVLQ | YGHYKYS | RLLYGLK | MSVLWCL | WPLVLALSIF | DCFVNFN |
| | | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | |
| <i>SARS-CoV-2</i> | 85 | ACLVGLMW | LSYFIAS | FRLFARTR | SMWSFN | PETNILL | NVPLHG | TILTRPL | LLESEL | VIGAVILR | GHLRIAG |
| <i>SARS-CoV</i> | 84 | ACIVGLMW | LSYFVAS | FRLFARTR | SMWSFN | PETNILL | NVPLRGT | IVTRPL | MESEL | VIGAVIIR | GHLRMAG |
| <i>HKU1</i> | 86 | TIISIVI | WILYFV | NSIRLFI | RTGSW | SFNPETN | NLMCID | MKGKMF | VRPVI | EDYHTL | TATVIR |
| <i>OC43</i> | 90 | TIVAIIM | WIVYFV | NSIRLFI | RTGSF | WFSFNP | ETNNLM | CIDMKG | TMYVRP | IIEDY | HTLTVT |
| <i>MERS-CoV</i> | 84 | AAVSAM | MWISYF | VQSIRL | FMRTGS | WWSFNP | ETNCLLN | VPFGGT | TVVRPL | VEDST | SVTAV |
| <i>229E</i> | 84 | AVSTL | VWVMYF | ANSFRL | FERRAR | TFWAWN | PEVNAI | TVTTVL | GQTY | YQPIQ | QAPTGI |
| <i>NL63</i> | 85 | SIITL | CLWVMY | FVNSFRL | WRVKT | FWAFNP | ETNAI | ISLQ | VYGH | NYLPM | MAAPT |
| | | 190 | 200 | 210 | 220 | 230 | | | | | |
| <i>SARS-CoV-2</i> | 175 | TL | SYKLG- | ASQ | RVAGD | SGFAA | YSRYR | IGNY | KLNTD | HSSSS | SDNIAL |
| <i>SARS-CoV</i> | 174 | TL | SYKLG- | ASQ | RVGTD | SGFAA | YNRYR | IGNY | KLNTD | HAGS | NDNIAL |
| <i>HKU1</i> | 177 | VL | CTYKRA- | FLD | KLDV | NSGF | AVFV | KSKV | GN | YRLP | SS-KP |
| <i>OC43</i> | 181 | HL | CTYKRG- | FLD | RISDT | SGFA | VYV | KSKV | GN | YRLP | STQK |
| <i>MERS-CoV</i> | 174 | VL | IALKMV- | KRQ | SYGT | NSGVA | IYH | RYK | AGN | YRS | PPITA- |
| <i>229E</i> | 175 | TT | IIYS | RVGR | SVNS | QNSTG | WVFY | VRV | KHG | DFSA | VSSP |
| <i>NL63</i> | 176 | TT | IVCD | RVGR | SVNET | SQTG | WAFY | VRA | KHG | DFSG | VASQ |

10 20 30 40 50 60 70 80 90 100 110 120

MHV-----MSSTTQAPEPVYQWTADAEAVQFLKEWNFSLGIILLFITIILQFGYTSRSMFIYVVKMIILWLMWPLTIVLCIFNCVYAL---NNVYLGFSI
 HKU14-----MSSTTTPAPVYIWTADAEAIKFLKEWNFSLGIILLFITIILQFGYTSRSMFVYVIKMIILWLMWPLTIILTIFNCVYAL---NNVYLGFSI
 GCCDC1-----MSGGNGTIPRSEVMAALRDWNFAISVLLFITALLQWGYPTCRCKPLWVIKMICILWLLWVPSIAAAVFAALYPI---NDVAFGFPI
 Hedgehog-CoV-----MSNDTLSQEEVIAVIKDNFNFSAVSVLFIITAVLQYGYPSRSMFVYVVKMFLWLLWPCSIACAVFSAVYPI---NLVSQIISG
 Bat-BCoV-----MSGDSNNTITQEELFKVVKKEWNFALGIMLFIFITILLQYAYATRSGLYIILKLVLLWLMWPLTFACFVLAAYIYHV---NVVFMGFPI
 Rat-CoV-----MSSTTSAPQTVYQWTADVAVRFLKEWNFLLGIILLFITIILQFGYTSRSMFIYVVKMIILWLMWPLTIVLCIFNCVYAL---NNVYLGFSI
 HKU24-----MSGQATTPEPIYSWTADAEAIRFLKEWNFSLGIILLFITIILQFGYTSRSMFVYVIKMIILWLMWPLTIILVIFNCVYAL---NNVYLGFSI
 SARS-CoV-----MADNGTITVEELKQLLEQWNLVIGFLFLAWIMLLQFAYSNNRNFYIILKLVFLWLLWVPLTACFVLAAYVRI---NWVTGGIAI
 HKU9-----MSNNTNTVPRPEVIAALKDNFNFSAVSVILLFITVLLQWGYPSRCKPIWVIKMFILWLLWPLSIAAAVFAAIHPI---NSVAFGFPI
 HKU5-----MASSNVTLNDEVLRVLDKNFNTWSVVFLLITIVLQYGYPSRSMFVYVIKMFVLLWLPASMAISIFCAVYPI---DLASQIISG
 HKU4-----MSSNGSLTKDEVVNIKDNFNSWSIIFLLITIVLQYGYPSRSMVYVFKMFILWLLWLPASMAISIFSAIYPI---SLSSQIISG
 Bovine-CoV-----MSSVTTAPVYTWTADEAIKFLKEWNFSLGIILLFITVILQFGYTSRSMFVYVIKMIILWLMWPLTIILTIFNCVYAL---NNVYLGFSI
 Covid-19-----MADSNGTITVEELKLLLEQWNLVIGFLFLTWICLLQFAYANRNFYIILKLVFLWLLWVPLTACFVLAAYVRI---NWITGGIAI
 HKU1-----MNKSFLPQFTSDQAVTFLKEWNFSLGVILLFITIILQFGYTSRSMFVYVIKMIILWLMWPLTITLTIFNCVYAL---NNAFLAFSI
 MERS-CoV-----MSNMTQLTEAQIIAIIKDNFNFSAVSVILLFITIVLQYGYPSRSMFVYVFKMFVLLWLPSSMAISIFSAVYPI---DLASQIISG
 OC43-----MSSKTTAPVYIWTADAEAIKFLKEWNFSLGIILLFITIILQFGYTSRSMFVYVIKMIILWLMWPLTIILTIFNCVYAL---NNVYLGFSI
 TGE-MKILLILACVI-----ACACGERYCAMKSDTDLSCRNSTA-SDCESCFNGGDLIWHLANWNFNSWSIILIVFITVLYGRPQFSWFVYGIKMLIMWLLWPVVALTIFNAYSEYQVSRYVMFGFSI
 FCoV MKYILLILACII-----ACVYGERYCAMQ-DSGLQ-CINGTN-SRCQTCFERGDLIWHLANWNFNSWSVILIVFITVLYGRPQFSWLVYGIKMLIMWLLWPIVVALTIFNAYSEYQVSRYVMFGFSV
 NL63-related-----MSTTMSNESIPLTEVYEHLRNWNFNSWNLVLTVFLVVLVLYGHFYQSKLLYALKMLVLLWPLVVALSIFDCWANFGK-DWVFFAFSL
 HKU2-----MSSNSTESVPVTEVLEHLRNWNFNSWNIILTVFIAVLQYGNMKSFFLYGVKMLIMWLLWPLVIALSIFNAYADFGV-NWVFFSFSI
 BtCoV512-----MSSNQSVPEEVIKHLRNWNFNSWNIILTILLVVLVLYGHYKYSRVLYGLKMAILWLLWPLVVALSIFDAWASFNV-NWVFFAFSI
 Porcine-EDV-----MSNGSIPVDEVIEHLRNWNFTWNIILTILLVVLVLYGHYKYSVFLYGVKMAILWLLWPLVVALSIFDAWASFQV-NWVFFAFSI
 BtNv-AlphaCoV-----MSSSNQTIPTVEVLEHLRNWNFAWNVILTVLLVVLVLYGNFKYSKVLYGLKMLVLLWPLVVALSIFNAWAEFNV-NWVFFSFSI
 BtMr-AlphaCoV-----MSDNSTVPVADVIEHLRNWFSAWNILLTLLIALLQYGNFKYSKLLYGLKMAILWLLWPCVIALSITNAWADFNV-NWAYFGISI
 Bat-CoV-1A-MINFIVLCCAFIGVI--YADNGD-----NTTAVTPTLPPQIPLKEVMEHLRNWNFNSWNVILTVFLVLMQYGHFKYSTILYGLKMLVLLWPLVVALSIFDAWSTFGQ-KWVMFAFSI
 Mink-CoV-MEVLLVAATAVLSVIPT-SHATNLYCLMNTTSVANNTCQNTN-GICDTCINEGNLIWHLMWNFNSWSVLLILFITILQYGRPQVSWFIYGIKMLIMWLLWPLVVALTIFNAYSEYTNTRYVMFGFSV
 BtRf-AlphaCoV-----MSNNTVPEVVEVLEHLRNWNFNSWNVILTVFLVVLVLYGQYKYSKLLYGLKMLILWLLWPLVVALSIFDSWASFNV-NWVFFAFSI
 HKU10-----MSNGDNSTIPTDVIQHLRNWNFNSWNVILTVFLVVLVLYGQYKYSKLLYGLKMLILWLLWPLVVALSIFDSWSSFGN-NWVFFAFSI
 CDPHE15-----MANGSVSEEEI IHHLRNWNFGWNIILTIFIVVLVLYGQYKYSKLLYGLKMLVLLWPLVVALSIFDAYASFNV-NWVFFAFSI
 Ferret-CoV MIEIVLLVCSAIAAMVPTTAASGNRYCLVNNTEGATQNC-----INDCIDEGSLIWHLMWNFNSWSVVLIVFIAILQYGRPQVSWFMYGVKMLIMWLLWPLVVALTIFNAYAEFKSSRYVMFGFSV
 LuchengRn-CoV-----MVLFCFNTSSADG-CSACVAQGCTGAGVTSASITWHLLNWNFNSWSVILTVFVSVLYGNLKYSMILYILKMIIMWLLWPIVIALTIFDAIETFKQERYVMFGFSI
 HKU8-MIF-----LILLGIIACASANGD-----NTTT-APPTVPQSIPEVQVVEHLRNWNFNSWNVILTVFLVVLVLYGQYKYSKLLYGLKMLVLLWPLVVALSIFDAWASFNV-NWVFFAFSI
 NL63-----MSNSSVPLLEVYVHLRNWNFNSWNLILTLFIVVLVLYGQYKYSRLLYGLKMSVWCLWPLVVALSIFDCVNFNV-DWVFFGFSI
 229E-----MSN-DNCTGDIVTHLKNWNFGWNVILTIFIVILQFGHYKYSRLLYGLKMLVLLWPLVVALSIFDTWANWDS-NWAFVAFSF



130 140 150 160 170 180 190 200 210 220 230 240 250

MHV VFTIVSIVIMWIMYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGTVYVRPIIEDYHTLTATIIRGHLYMQGVKLTGFSLSDDLPAVYTVAKVSHLCTYKR-AFLDKVDGVS GF FAVYVKS KVGNYRLPS

HKU14 VFTIVAIIMWIVYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGRMYVRPIIEDYHTLVTIIRGHLYIQGIKLGTGYSLSDDLPAVYTVAKVTHLCTYKR-GFLDRIGDTS GF FAVYVKS KVGNYRLPS

GCCDC1 TFACISSIMWLSYFISFRLLCRTGSPWFSMPETNMLLNVPILGRVTTRPILADSPAVQFLILRGDLRFEGFNLGQC-RPGEMPTDITVAKAASLHWYKK-ALTRAIGKESAIIVYIKYKVGNYRNVQ

Hedgehog-CoV LLAAVSVFMWLG YFLQSFRLFRRTGSWWSFNPETNCLLNVPIGGTTVVRPLVEDSTSVTAVVTNGYLMKAGMHFGQC-DYSRPLTEITVAKPNVLIALKM-VKRQDYGVNSGVAIYHRYKAGNYRRPP

Bat-BCoV TFAIIVGCMWLG YWIASIRLFI RTGSWWSFNPETNRLLNVAIRGTMVTRPLQEDTAVIVATVARGVAVFAGHKLGRA-DLES LPNEITVATSRTL SYFKM-SRKVNIGVSGVATYLRYKVGNYRVPN

Rat-CoV VFTIVSIVIMWIMYFVNSIRLFI RTGSWWSFNPETNNLMCIDVKGTVYVRPIIEDYHTLTATNVRGHLYMQGVKLTGFSLSDDLPAVYTVAKVSHLCTYKR-AFLDKVDGVS GF FAVYVKS KVGNYRLPS

HKU24 VFAIVSIIIMWIVYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGRMFVRPIIEDYHTLVTIIRGHLYIQGIKLGTGYTSLDDLPAVYTVAKVTHICTYKR-AFLDKIGDIS GF FAVYVKS KVGNYRLPS

SARS-CoV AMACIVGLMWLSYFVASFR L FARTRSMWSFNPETNILLNVP LRG TIVTRPLMESELVIGAVIIRGH LRMAGHSLGRC-DIKDLPKEITVATSRTL SYYKL-GASQRVGTD SGFAAYNRYRIGNYKLN

HKU9 AFACISGIMWLSYFISFRLLCRTGSAWSFMPETDMLINIPLLGRVTTRPIISD SPAVQFLIIRGELRFDGFTLGRC-DPGDMPDIVTIARPNALHWYKR-ALTRNMYTRSAILVYIKYKVGNYRNVQ

HKU5 ILAATSCAMWISYFVQSIRL FMRTGSWWSFNPESNCLLNVP IGGTTVVRPLVEDSTSVTAVVTDGYLMKAGMHFGAC-DFQRLPSEVTVAKPNVLIALKM-IKRQAYGTNSGVAIYHRYKAGNYRRPP

HKU4 ILAAICAVMWL LAYFVQSIRL FMRTGSWWSFNPESNCLLNVP IGGTTVVRPLVEDSTSVTAVVNDGHLK MAGMHFGRC-DYDRLPMEITVAKPSVLIALKM-VKRQSYGTNSGVAIFHRYKAGNYRRPT

Bovine-CoV VFTIVAIIMWIVYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGRMYVRPIIEDYHTLVTIIRGHLYMQGIKLGTGYSLSDDLPAVYTVAKVSHLLCTYKR-GFLDKIGDTS GF FAVYVKS KVGNYRLPS

Covid-19 AMACLVLGMWLSYFIASFRL FARTRSMWSFNPETNILLNVP LHG TILTRPLLESELVIGAVILRGHLRIAGHHLGRC-DIKDLPKEITVATSRTL SYYKL-GASQRVAGD SGFAAYSRYRIGNYKLN

HKU1 VFTIISIVIWILYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGKMFVRPIIEDYHTLTATVIRGHLYIQGIVKLTGYSLSDDLPAVYTVAKVQVLCYTKR-AFLDKLDVNS GF FAVFVKS KVGNYRLPS

MERS-CoV IVAAVSAMWISYFVQSIRL FMRTGSWWSFNPETNCLLNVP FGGTTVVRPLVEDSTSVTAVVTNGHLMKAGMHFGAC-DYDRLPNEVTVAKPNVLIALKM-VKRQSYGTNSGVAIYHRYKAGNYRSP

OC43 VFTIVAIIMWIVYFVNSIRLFI RTGSWWSFNPETNNLMCIDMKGTMVVRPIIEDYHTLVTIIRGHLYIQGIKLGTGYSLADLPAYMTVAKVTHLCTYKR-GFLDRISDTS GF FAVYVKS KVGNYRLPS

TGE AGAIVTFVLWIMYFVRSIQLYRRTKSWWSFNPETKAILCVSALGRSYVPLEGVPTGVTLTLLSGNLYAEGFKIAGGMNIDNLPKYVMVALPSRTIVYTLVKGKLLKASSATGWAYYVKS KAGDYSTE

FCoV AGAVVTFALWMMYFVRSVQLYRRTKSWWSFNPETNAIILCVNALGRSYVPLDGTPTGVTLTLLSGNLYAEGFKMAGGLTIEHLPKYVMIAATPSRTIVYTLVKGKLLKASSATGWAYYVKS KAGDYSTE

NL63-related LMTIITLCLWIMYFVNSFKLYRRVKTWF AFNPETNAIISLQVYGHNYQPVMTAPTGVTLTLLSGVLLIEGHKVAIRVQVQQLPKYLIVATPRTTIIYDRVGRSVNESSQTGWAFYVRSKHGDFSGIA

HKU2 LMLVITLVLWLMYIINSFKLYRRTTFWAFNPETDAIAVISVFGRSYSIPMPVAPTGITLTLISGTLFFDGIRIATGVQPAHLQFVTVAKPGTTIIYTRAGRSLNASTNTGWAFYVRSKHGDYSALS

BtCoV512 LMACVTAVLWIMYFVNSIRLWRRTHSWWSYNPETDSILSVSVLGRHVCLPILGAPTGVTLTLLNGTLLVEGYQVATGVQVNNLPGYVTVAKASTTIVYQRVGRSMNANSSTGWAFVRSKHGDYAAA

Porcine-EDV LMACITLMLWIMYFVNSIRLWRRTHSWWSFNPETDALLTTSVMGRQVCIPVLGAPTGVTLTLLSGTLLVEGYKVATGVQVSQLPNFVTVAKATTTIVYGRVGRSVNASSGTGWAFYVRSKHGDYSAVS

BtNv-AlphaCoV IMACVTFVLWIMYFVNSFKLYRRTQTFWAFNPETDAIITLVNFGRTVAIPVITAPTGITLTVLNGQLLVEGYKVANGVQVQQLPSYVTVAKPSTTTIIYQVRSRSINVRSN TGWAFVRSKHGDFSSALA

BtMr-AlphaCoV FMLVVTLVLWIMYFVNSFRLYRRTSFWAFNPETDSIIIVFSVYGTYSIPVIQAPQGIFFTVLSGTLLVDGIKVATGVRIEALPQYVTVAKATTTIVFHRVGKAVNERTQTGWLFFVRSYGDYAAHS

Bat-CoV-1A VMACTTLVLWLMYFINSFRLYRRTQSFWAFNPETDAIITISVFGKTVAIPLVPPGTITLTVLSGKLLVEGIPVANGITVGQLPEFVTVAKATTTIIYRRAGRSLNAKTQTGWAFYVRAKNGDYSAIM

Mink-CoV AGSVLTFVLWVWYFVRSIQLWRRTRTWWSFNPETNAIILCLNAVGNRFVPLPLNGAPTGITLTLTLLSGNLYAEGFKVSGSVNENLPKYVMVATPGNTIVYHQQVGSLSKAA NSTGWSYVRAKAGDYSTE

BtRf-AlphaCoV LMSCITLVLWIMYFVNSFRLYRRTQTFWAFNPETDAIITLSVFGQVSIPTIVVPTGITLTVLSGTLTLLVEGIVKATGVQVSQLPTYLTVAKPFSTTTIIYQRAGRSVNARSNTGWAFYVRSKHGDYSAVS

HKU10 LMACITLVLWIMYFVNSFRLYRRTNTFWAFNPETDAIITLSVFGQVSIPTIVVPTGITLTVLSGTLTLLVEGIVKATGVQVSQLPTYLTVAKPFSTTTIIYQRAGRSVNARSNTGWAFYVRSKHGDYSAVT

CDPHE15 LMACVTGVLWVWYFVNSIRLWRRTHSWWSFNPETDITLATTVLGRVTYLPALPAAPTGVTLTLLNGTLLVEGFVAVGVTVVELLPDYVVVAKPHSTTTIIYQVGRSVNARSNTGWSFYVVKAKYGDYATTG

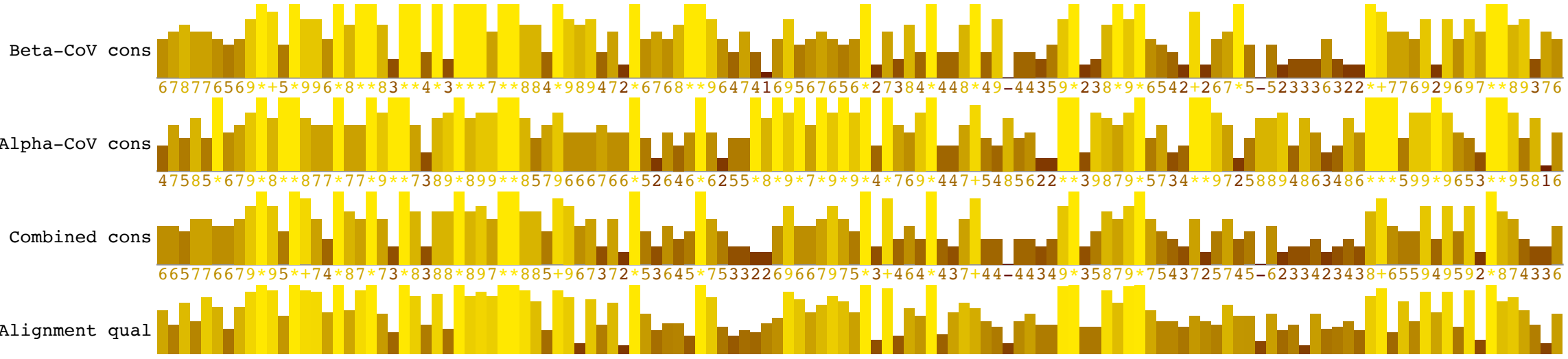
Ferret-CoV SGAMVTLVMWIMYFARSIQLWRRTRTWWSFNPETNAIILCLSSVGKRFVPLSGAPTGVTLTLLSGNLYAEGFKVSGSVNVDNLPKYIMVATPGNTIVYHQQVGSLSKASSATGWSYVRAKAGDYSTE

LuchengRn-CoV ALGVVTLILWIMYFVNSFRLYRRTGSWWSFNPETNAIICVSVMGRNITTPVSPGTITLTLTLLSGTLYVEGQRAATGVNLDNLPNYVTVAKPGVTIVYHRVGKSI RVSTATGMYVYVKS KAGDYSAYS

HKU8 VMACTTLMLWIMYFVNSFRLYRRCQSFWAFNPETDAVITLSVFGKIVAIPLVMPPTGITLTLISGKLLVEGIPVANGVSVTQLPSYVTVAKATTTIIYQVGVKSLNAASQTGWAFYVRAKNGDYSAVS

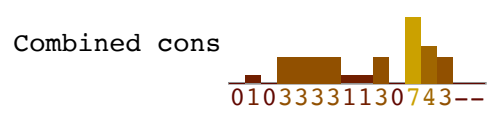
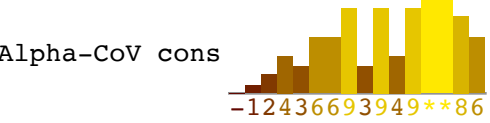
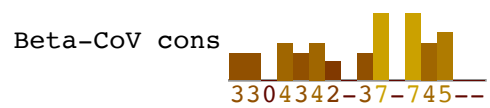
NL63 LMSIITLCLWVWYFVNSFRLWRRVKTWF AFNPETNAIISLQVYGHNYLPVMAAPTGVTLTLLSGVLLVDGHKIATRQVQQLPKYVIVATPSTTTIVCDRVGRSVNETSQTGWAFYVRAKHGDFSGVA

229E LMAVSTLVMWVWYFANSFR LFRRTTFWAWNPEVNAITVTTVLGOTYYOPIOAPTGITVTLTLLSGVLYVDGHRLASGVOVHNLPEYMTVAVPSTTTIIYSRVGRSVN SONSTGWVYVVRVKHGDFSAVS



260 270

MHV NK-PSGADTALLRT--
 HKU14 TQKGTGMDTALLRNNI
 GCCDC1 AREDGDTIAM-FIA--
 Hedgehog-CoV VVVDEEL-AL-LRA--
 Bat-BCoV ARASEDQEDLLVVS--
 Rat-CoV NK-PSGADTALLRI--
 HKU24 SQKGNMGMDTALLRNNV
 SARS-CoV DHAGSNDNIALLVQ--
 HKU9 TTEDGDRLAM-FVA--
 HKU5 IIQDQEL-AL-LRA--
 HKU4 IIQDEEL-AL-LRA--
 Bovine-CoV TQKGSGLDTALLRNNI
 Covid-19 DHSSSSDNIALLVQ--
 HKU1 SK-PSGMDTALLRA--
 MERS-CoV ITADIEL-AL-LRA--
 OC43 TOKGSGMDTALLRNNI
 TGE -RTDNLSEQEKLHLMV
 FCoV -RTDNLSEHEKLLHLMV
 NL63-related SQENVLSEREKLLHLV
 HKU2 NSSDNLTEHDRLLHLV
 BtCoV512 NPTEVVTDSEKILHLV
 Porcine-EDV NPSAVLTDSEKVLHLV
 BtNv-AlphaCoV TDNETMTERERLLHLV
 BtMr-AlphaCoV TGTGQMTSEKLLHIA
 Bat-CoV-1A TMADSFSENERLLHLV
 Mink-CoV -RNDNLSEHEKLLHLMV
 BtRf-AlphaCoV SHSDSMTEDEVLHLV
 HKU10 SSADSLTEDEKLLHLV
 CDPHE15 HSNDKVPDSEVVLHLV
 Ferret-CoV -RHDNLSEHEKLLHLMV
 LuchengRn-CoV -SGGSLSDQEQLLHLMV
 HKU8 NPSDSYTDTRLLHLV
 NL63 SQEGVLSEREKLLHLI
 229E SPMSNMTENERLLHFF



Nucleocapsid (N) protein

| | | | | | | | | | | |
|-------------------|---|------------------|------------|----------|----------|-----------|----------|-----------|----------|--------------------------|
| | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| <i>SARS-CoV-2</i> | 1 | MSD-NGPQ-NQ----- | RNAPRITFGG | PSDSTGSN | QNGERSG | ARSK----- | QRRPQGLP | NNTASW | FALTQHGK | -EDLKFPRGQGV |
| <i>SARS-CoV</i> | 1 | MSD-NGPQSNQ----- | RSAPRITFGG | PSTDNDN | QNGGRNG | ARPK----- | QRRPQGLP | NNTASW | FALTQHGK | -EELRFPRGQGV |
| <i>HKU1</i> | 1 | MSYTPGHYAGSRSSSG | NRSGILK | KTSWADQ | SERNYQ | TF---- | NRGRKTQ | PKFTVST-- | QPQGN | TIPHYSWFSGITQFQKGRDFKFS |
| <i>OC43</i> | 1 | MSFTPGKQSSSRASS | GNRSGNG- | ILKWADQ | SDFRNVQ | ---- | TRGRR | AQPKQTATS | QPPSGG | NVVPPYYSWFSGITQFQKGKFEFV |
| <i>MERS-CoV</i> | 1 | -----MASP----- | AAPRAVS | FADNND | ITNTN--- | LSRGRGR- | ----- | NPKPRA | APNNTV | SWYTGLTQHGK-VPLTFPPGQGV |
| <i>229E</i> | 1 | ----- | MATVKW | ADASEPQ | ----- | RGRO----- | ----- | GRI | PYSLYS | PLLVDSEQPWKVIPRNLV |
| <i>NL63</i> | 1 | ----- | MASVNW | ADDRAA- | ----- | RK----- | ----- | KFP | PPSFY | MPLLVSSDKAPYRVIPRNLV |

| | | | | | | | | | | |
|-------------------|----|-------------------|----------|---------|---------|---------|--------|--------|--------|----------------------------|
| | | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 |
| <i>SARS-CoV-2</i> | 73 | PINTNSSPDDQIGYYR | RATRR-IR | GGDGKMK | DLSPRWY | FYYLGTG | PEAGL | PGANKD | GIIWVA | TEGALNTPKDHIGTRNPANNAATV |
| <i>SARS-CoV</i> | 74 | PINTNSGPDDQIGYYR | RATRR-VR | GGDGKMK | ELSPRWY | FYYLGTG | PEASL | PGANKE | GIVVVA | TEGALNTPKDHIGTRNPNNNAATV |
| <i>HKU1</i> | 86 | PIAFGVPPSEAKGYWY | RHSRRS | FKTADG | QOKQLL | PRWYFYY | LGTG | PYANAS | YGESLE | GVFVWANHQADTSTPSDVSSRDPTTQ |
| <i>OC43</i> | 87 | PIAPGVPAATEAKGYWY | RHNRRS | FKTADG | NQRQLL | PRWYFYY | LGTG | PHAKDQ | YGTDID | IGVYVWASNOADVNTPADIVDRDPSS |
| <i>MERS-CoV</i> | 64 | PLNANSTPAQNA | GYWRRQ | DRK-INT | GNG- IK | QLAPRWY | FYYTGT | GPEAAL | PFRAVK | DGIVVWHEDGATDAPS-TFGTRNP |
| <i>229E</i> | 45 | PVNKKD-KNKL | IGYWNV | QKR-- | FRTRK | GKRVDL | SPKLF | FYYLGT | GPHKDA | KFRFRVEG |
| <i>NL63</i> | 43 | PIGKGN-KDEQ | IGYWNV | QER-- | WRMRR | GQRVDL | PEKVH | FYYLGT | GPHKDL | KFRQRSDG |

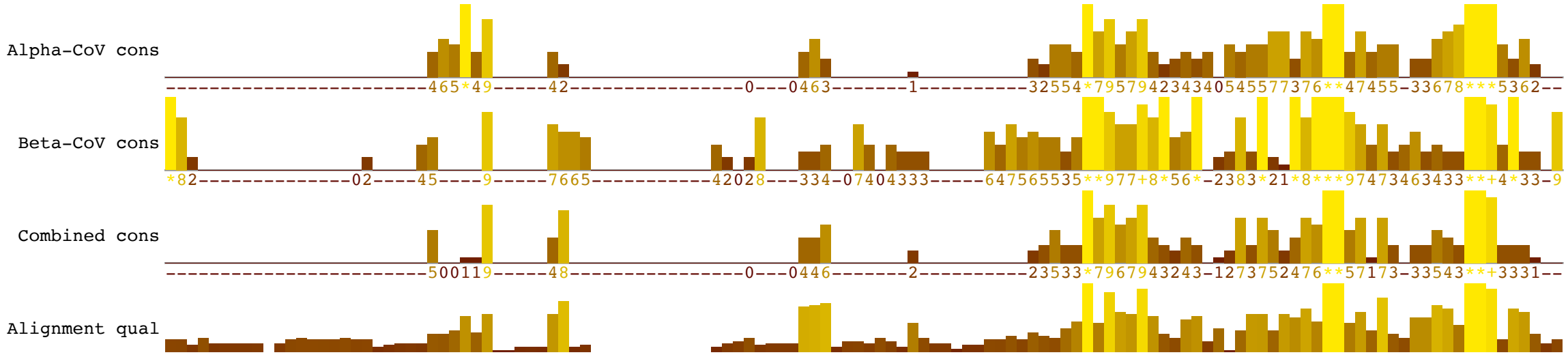
| | | | | | | | | | | |
|-------------------|-----|-----------------|----------|----------|--------|--------|---------|-------------|------------|---------------------------------|
| | | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 |
| <i>SARS-CoV-2</i> | 163 | QGTTLPKGFYAEGSR | GGSQASS | RRSSS-- | RSRNS | SRNSTP | GSRRG-T | SPARMA----- | GNGGDA | ALALLLLDRLNQLESK-MSGKG--Q-Q |
| <i>SARS-CoV</i> | 164 | QGTTLPKGFYAEGSR | GGSQASS | RRSSS-- | RSRGN | SRNSTP | GSRRG-N | SPARMA----- | SGGETA | LALLLLDRLNQLESK-VSGKG--Q-Q |
| <i>HKU1</i> | 177 | PGTILPQGYVVEG | SGRSASN- | SRP--- | GSR | SQSRGP | NNRSL | SRNSN | FRHS----- | DSIVKPDMADEIANL-VLAKLGKD-S |
| <i>OC43</i> | 178 | PGTILPQGYVIEG | SGRSASN- | SRS--- | TSRT | SSRASS | AGSR | SRANS | GNRTP----- | TSGVTPDMADQIASL-VLAKLGKD-A |
| <i>MERS-CoV</i> | 152 | PGTKLPKNFHIEG | TGGNSQ | SSSRASS- | LSRNS | SRSSSQ | GSRRG-N | STRGTS--- | PGPSG | IGAVGGDLLYLDLLNRLQAL-ESGKV--K-Q |
| <i>229E</i> | 130 | -NQKLPNGVTVA | EEPDSR- | ----- | APSR | SQRS | SRSR | VESKS | QS-RNP | SSDRNHNSQDDIMKAVAAALKSLGFDK |
| <i>NL63</i> | 128 | -SIALPPELSV | VEFEDR | SNNSS | RASSRS | SSTRNS | SRDSS | RSTSRQ-Q | SRTR | SDSNQSSSDLVAAVTLALKNLGF |

| | | | | | | | | | | |
|-------------------|-----|----------------|---------|--------|--------|-----------|-------|-------|------------|------------------------------|
| | | 280 | 290 | 300 | 310 | 320 | 330 | 340 | 350 | 360 |
| <i>SARS-CoV-2</i> | 241 | QGGQT-VTK----- | KSAA--- | EASKK | PRQKRT | TATKA-- | YNV | TQAF | RRGPEQ | TQGNFGDQELIRQGT |
| <i>SARS-CoV</i> | 242 | QGGQT-VTK----- | KSAA--- | EASKK | PRQKRT | TATKQ-- | YNV | TQAF | RRGPEQ | TQGNFGDQDLIRQGT |
| <i>HKU1</i> | 248 | -KPQQ-VTK----- | QNAKE | IRHKIL | TKPRQ | KRTPNKH-- | CNV | QCFG | KRGPSQ--- | NFGNAEMLKLG |
| <i>OC43</i> | 249 | TKPQQ-VTK----- | HTAKE | VRQKIL | NKPRQ | KRSPNKQ-- | CTV | QCFG | KRGPNQ--- | NFGGEMLKLG |
| <i>MERS-CoV</i> | 233 | SQPKV-ITK----- | KDAA--- | AAKN | KMRHK | RSTSTKS-- | FNM | VQAF | GLRGP | DLQGNFGDLQLNKLGTEDPRWPQIA |
| <i>229E</i> | 214 | SRNQSPASSQ | SAKILAR | SQSSET | KEQKHE | MOKPRW | KRQPN | DDVTS | NVTQ | CFGPRDLDH--NFGSAGVVANGVKAKGY |
| <i>NL63</i> | 214 | KKPNKPL----- | SQPRAD | KPSQL | KKPRW | KRVPTRE-- | ENV | IQCF | GPRDFNH--- | NMGSDLVQNGVD |

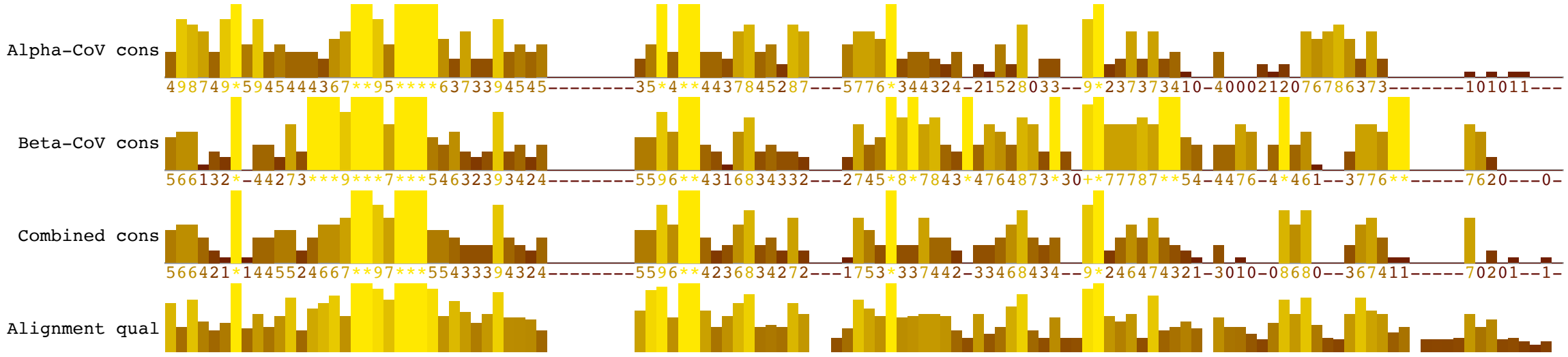
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|-------------------|-----|--------------------|--------|--------|--------|---------|-----------|------------|--------|-------------------------------------|
| | | 370 | 380 | 390 | 400 | 410 | 420 | 430 | 440 | 450 |
| <i>SARS-CoV-2</i> | 314 | FFGMSRIGMEVTP----- | SGTWL | TYTGAI | KLDDK | DPNFKD | QVILL | NKHID | AYKTF | FPPEPKDKKKKAD--ETQALPQRQ---- |
| <i>SARS-CoV</i> | 315 | FFGMSRIGMEVTP----- | SGTWL | TYHGAI | KLDDK | DPQFKN | VILL | NKHID | AYKTF | FPPEPKDKKKKTD--EAQPLPQRQ---- |
| <i>HKU1</i> | 321 | FFFSGKLDLVKRD--- | SEAD | SPVKD | VFELH | YSGSIR | FDSTL | PGFET | IMKV | LEENLNAYVNSNQ-----NTDSDSLSSK |
| <i>OC43</i> | 323 | FFFSGRLELAKV | QNLSGN | PDEPQ | KDVYEL | RYNGAIR | FDSTL | SGFET | IMKV | LENLNAYQOQDG-----MMNSPKPQRQRGHKN |
| <i>MERS-CoV</i> | 306 | FMGMSQFKLTHQN---- | NDDH | GNPV | YFLRY | SGAIKL | DPKN | PNYNK | WLELLE | QNIIDAYKTFPKKEKKQKAPKEESTDMQSEPPKEQ |
| <i>229E</i> | 302 | MLFDSHIVSKESG----- | NTVVL | TFTTR | VTVPK | DHPL | GLKLEE--- | LNA | FTREM | QQPLLNP-----SALEFN----- |
| <i>NL63</i> | 287 | LFFDSEVSTDEVG----- | DNVQ | ITYTY | KMLV | AKDN | KNL | PKFIEQ---- | ISAF | TKPSSIKEMQSQ-----SSHVAQ----- |

| | | | | | | |
|-------------------|-----|--------|--------------|-------|-------|-----------|
| | | 460 | 470 | 480 | 490 | 500 |
| <i>SARS-CoV-2</i> | 387 | ---- | KKQQT----- | VTLL | PAADL | DDFSKQLQ |
| <i>SARS-CoV</i> | 388 | ---- | KKQPT----- | VTLL | PAADM | DDFSRQLQ |
| <i>HKU1</i> | 400 | LPEQ | FDSLNL | SA--- | GTQH | ISNDF |
| <i>OC43</i> | 402 | GQGEND | NISVAV | PKSRV | QQNK | SRELTA |
| <i>MERS-CoV</i> | 392 | ITQR | TRTRPS----- | VQPG | MIDV | NNTD----- |
| <i>229E</i> | 363 | ---- | P--SQTSP---- | ATVE | PVRDE | VSIE |
| <i>NL63</i> | 348 | ---- | NTVLNASI---- | PESK | PLADD | SAII |

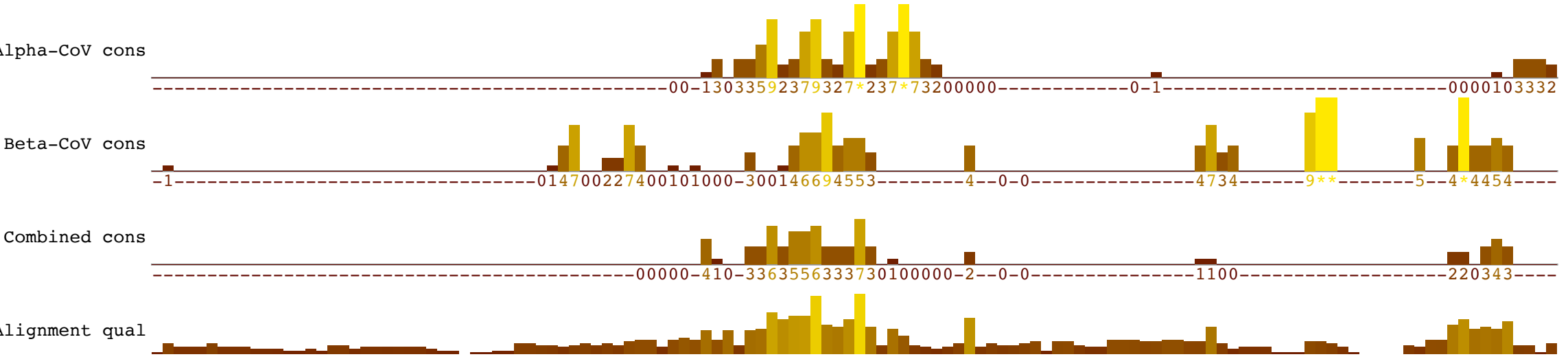
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|---------------|---|------|-------------|--|-----------|--|----|----|----|-----|-----|-----|
| MHV | MSFVPGQENAGGRSSSVNRAGNGILKKTW | ADQT | ERGPNNQNRGR | RNQPQTATT | QPNSGSVVP | PHYSWFSGITQFQKGFQFAEGQGVPIANGIPASEQKGYWRHNRR | | | | | | |
| HKU14 | MSFTPGKQP-SSRASSGNRAGNGILK--W | ADQS | EQSRNIQTRGR | RAQPKQTVTSQOPTGGNVVPPYYSWFSGITQFQKGFQFAEGQGVPIAPGVPATEAKGYWRHSRR | | | | | | | | |
| GCCDC1 | MSGR-----NT-PKGRQ---TP-KVSFKQESDSDSE--ADRHTTRNGARPKT--NNGP--ATIKPEK---- | | | | | PRAAPMNQVSWFAPLVOTGK--SDLKFAHGEGVPSVQGVDTGTYQHGYWLRTO-R | | | | | | |
| Hedgehog-CoV | MAT-----PQ---QPRAVTF--ADNN-----GNQON-----GNN-RGRPRQPK----- | | | | | PRPAPNVSVSWYTGITQHGK-QPLAFPAQGVPLNANSTPKQYAGYWRROD-R | | | | | | |
| Bat-BCoV | MAA-----E--GQ-RVTFLTQGSNQN-----NNQEN--QDGR-GARPKTRK----- | | | | | PRPAPQNNVSWYTGITQHGK-QALTFNPGQGVPLNANDDPDSRIGYWRRNI-R | | | | | | |
| Rat-CoV | MSFVPGQENAGSRSSSGNRAGNGILKKTW | ADQT | ERQNNNGNRGR | RNQPQTATT | QPNTGSVVP | PHYSWFSGITQFQKGFQFAAGQGVPIANGIPSSQKGYWRHNRR | | | | | | |
| HKU24 | MSHTPGKAG-S-RSSSGNR-NGGILK--W | ADQT | EP-NNVNSRGR | RAQPKQTANT | QASGGNVV | PFYWSFGITQFQKGFQFEGQGVPLTNGVPPSEKGYWRHNRR | | | | | | |
| SARS-CoV | MSDN-----GPQSNQRS---AP-RITF--GGPTDST | | | | | DNNQN--GGRN-GARPKQRR-----POGLPNNTASWFTALTQHGK--EELRFPRGQGVPIINTNSGDDQIGYRRAT-R | | | | | | |
| HKU9 | MSGR-----NRSRSGTP---SP-KVTFKQESDGSDESERRNGNRNGARPKN--NNSR-GSAPKPEK---- | | | | | PKAAPQNVSWFAPLVOTGK--AELRFPRGEGVPSVQGVDTSTYEHGYWLRTO-R | | | | | | |
| HKU5 | MAT-----PA---PPRAVVF--ANDN-----ETPTN---SOR-SGR-PRTK----- | | | | | PRPAPNNTVSWYTGITQHGK-QPLAFPPGQGVPLNANSTPAQYWRROD-R | | | | | | |
| HKU4 | MAT-----PA---APRTISF--ADNN-----DNQPN---QQQ-RGRGRNPK----- | | | | | PRPAPNNTVSWYTGITQHGK-NPLAFPPGQGVPLNANSTTAQYWRROD-R | | | | | | |
| Bovine-CoV | MSFTPGKQS-SSRASSGNRSGNGILK--W | ADQS | DQSRNVQTRGR | RAQPKQTATSQQPSGGNVVPPYYSWFSGITQFQKGFQFAEGQGVPIAPGVPATEAKGYWRHNRR | | | | | | | | |
| Covid-19 | MSDN-----GPQ-NQRN---AP-RITF--GGPSDST | | | | | GSNQN--GERS-GARSKQRR-----POGLPNNTASWFTALTQHGK--EDLKFPRGQGVPIINTNSPDDQIGYRRAT-R | | | | | | |
| HKU1 | MSYTPGHYA-GSRSSSGNR--SGILKKTW | ADQS | ERNYQTFNRGR | KTQPKFTVSTQ | POGNTI | PHYSWFSGITQFQKGRDFKFSGQGVPIAFGVPVSEAKGYWRHSRR | | | | | | |
| MERS-CoV | MAS-----PA---APRAVSF--ADNN-----DITNT---NLS-RGRGRNPK----- | | | | | PRAAPNNTVSWYTGITQHGK-VPLTFVPGQGVPLNANSTPAQYWRROD-R | | | | | | |
| OC43 | MSFTPGKQS-SSRASSGNRSGNGILK--W | ADQS | DOFRNVOTRGR | RAQPKQTATSQQPSGGNVVPPYYSWFSGITQFQKGFQFAEGQGVPIAPGVPATEAKGYWRHNRR | | | | | | | | |
| TGE | MAN-----QGQVRSW--GDES-----T--K--TRGRSRSRGRKN----- | | | | | NNIPLSFFNPITLQGSKFWNLCPDRDFVPKIGN-RDQDIGYWRNQT-- | | | | | | |
| FCoV | MAT-----QGQVRSW--GDES-----S--K--RRGRSRSRGRKN----- | | | | | NDIPLSFFNPITLQGSKFWNLCPDRDLVPKIGN-KDQDIGYWRNQT-- | | | | | | |
| NL63-related | | | | | | | | | | | | |
| HKU2 | | | | | | | | | | | | |
| BtCoV512 | | | | | | | | | | | | |
| Porcine-EDV | | | | | | | | | | | | |
| BtNv-AlphaCoV | | | | | | | | | | | | |
| BtMr-AlphaCoV | | | | | | | | | | | | |
| Bat-CoV-1A | | | | | | | | | | | | |
| Mink-CoV | | | | | | | | | | | | |
| LuchengRn-CoV | | | | | | | | | | | | |
| BtRf-AlphaCoV | | | | | | | | | | | | |
| HKU10 | | | | | | | | | | | | |
| CDPHE15 | | | | | | | | | | | | |
| Ferret-CoV | | | | | | | | | | | | |
| HKU8 | | | | | | | | | | | | |
| NL63 | | | | | | | | | | | | |
| 229E | | | | | | | | | | | | |



| | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 |
|----------------------|--------------------------------------|-------|-------------------------------|-------|--------------------------------------|------------|-------------------|--------|--------|-------|--------|-------|----------|
| <i>MHV</i> | SFKTPDGQOKQLLPRWYFYFLGTGPHAGASYGDSI | ----- | EGVFWVANSQADTNTR | ----- | SDIVERDPSSHEAIPTRFAPGTVLPQGFYVEGSG | RSAP-ASRSG | ----- | SRSQSR | ----- | GP | ----- | NNR | |
| <i>HKU14</i> | SFKTADGNQRQLLPRWYFYFLGTGPHAKDQYGTDI | ----- | DGVFWVASNQADVNTNTP | ----- | ADILDRDPSSDEAIPTRFPFGTTLVLPQGYIIEGSG | RSAP-NSRST | ----- | SRASSR | ----- | ASSA | ----- | GSR | |
| <i>GCCDC1</i> | NFTKG-GKSLTANPRWYFYFLGTGRYADLRFGRTRQ | ----- | PDILVWGRGNANVNKVS | ----- | GNMGTRNPNNSDAIPVQLPEG | ----- | IPKGFYAEAGTR | ----- | SRNSSR | ----- | RGSSR | ----- | NTSAS |
| <i>Hedgehog-CoV</i> | KLNTGNG-VKQLAPRWYFYFLGTGPEANLPFRTVK | ----- | DGIYVWVEEGASEAPV | ----- | DFGTRNPANDAIAIVTQFAPGTQLPKNCHIEGTG | ----- | GNSQSSSRASSASRNSR | ----- | SNSRG | ----- | SO | | |
| <i>Bat-BCoV</i> | TVT-KNGKPQKLDPRWYFYFLGTGPEANLKYLOKQ | ----- | DGIVVVAHAGLANVPV | ----- | KTVGTRNPANDAIAIVAFAPGTLPKGFYVEGSR | ----- | STSSASSAASSRNSR | ----- | SNSLS | ----- | R | | |
| <i>Rat-CoV</i> | SFKTPDGQOKQLLPRWYFYFLGTGPHAGASFGDSI | ----- | EGVFWVANSQADTNTR | ----- | ADIVERDPSSHEAIPTRFAPGTVLPQGFYVEGSG | RSAP-ASRSG | ----- | SRSQSR | ----- | GP | ----- | NNR | |
| <i>HKU24</i> | SYRTADGQORQLLPRWYFYFLGTGPIYANKQYGSDI | ----- | DGVVWVASPNVDVRSR | ----- | ADVPDRDPTSHQAEPTRFAPGTVLPKGFYVEGSG | RSAP-SSR | ----- | SRASSR | ----- | ASSV | ----- | GSR | |
| <i>SARS-CoV</i> | RVRGGDGKMKELSPRWYFYFLGTGPEASLPYGANK | ----- | EGIVWVATEGALNTPK | ----- | DHIGTRNPNNAATVQLPQGTTLKGFYAEGR | ----- | GGSQASSRSSSR | ----- | SRGNSR | ----- | NSTPG | | |
| <i>HKU9</i> | SFQKG-GKQVLANPRWYFYFLGTGRFGDLRFGTGN | ----- | PDIVWVQEGANINRL | ----- | GDMGTRNPSNDGAIPVQLAGG | ----- | IPKGFYAEGR | ----- | SRGNSR | ----- | RNSSR | ----- | ASSRG |
| <i>HKU5</i> | KINTGNG-TKPLAPRWYFYFLGTGPEANLPFRSVK | ----- | DGIIVWHENGATDAPS | ----- | VFGTRNPANDPAIVTQFAPGTTLKPNFHIEGTG | ----- | GNSQSSSRASS | ----- | RSSSR | ----- | SSSRN | ----- | GR |
| <i>HKU4</i> | KINTGNG-VKQLAPRWYFYFLGTGPEANLPFRSVK | ----- | DGIVVWYEEGATDAPS | ----- | VFGTRNPANDAIAIVCQFAPGTTLKPNFHIEGTG | ----- | GNSQSSSRASSNSRNSR | ----- | SSSRG | ----- | GR | | |
| <i>Bovine-CoV</i> | SFKTADGNQRQLLPRWYFYFLGTGPHAKDQYGTDI | ----- | DGVYVVASNQADVNTNTP | ----- | ADILDRDPSSDEAIPTRFPFGTTLVLPQGYIIEGSG | RSAP-NSRST | ----- | SRASSR | ----- | ASSA | ----- | GSR | |
| <i>Covid-19</i> | RIRGGDGKMKDLSRWYFYFLGTGPEAGLPYGANK | ----- | DGIIVWVATEGALNTPK | ----- | DHIGTRNPANNAIVLQPLPQGTTLKGFYAEGR | ----- | GGSQASSRSSSR | ----- | SRNSR | ----- | NSTPG | | |
| <i>HKU1</i> | SFKTADGQOKQLLPRWYFYFLGTGPIYANASYGESL | ----- | EGVFWVANHQADTSTP | ----- | SDVSSRDPTTQEAIPTRFPFGTTLVLPQGYIIEGSG | RSAS-NSRPG | ----- | SRSQSR | ----- | GPNN | ----- | RSL | |
| <i>MERS-CoV</i> | KINTGNG-IKQLAPRWYFYFLGTGPEAALPFRVAVK | ----- | DGIVVWHEDGATDAPS | ----- | TFGTRNPNNSDAIVTQFAPGTTLKPNFHIEGTG | ----- | GNSQSSSRASSL | ----- | SRNSR | ----- | SSSQ | ----- | SR |
| <i>OC43</i> | SFKTADGNORQLLPRWYFYFLGTGPHAKDQYGTDI | ----- | DGVYVVASNQADVNTNTP | ----- | ADIVDRDPSSDEAIPTRFPFGTTLVLPQGYIIEGSG | RSAP-NSRST | ----- | SRTSSR | ----- | ASSA | ----- | GSR | |
| <i>TGE</i> | RYRMVKGQRKELPERWFFYFLGTGPHADAKFKDKL | ----- | DGVVWVAKDGMNKPT | ----- | TLGSRGANNES-KALKFDGK | ----- | VPGEFQLEVNQ | ----- | SRDNSR | ----- | SRSR | ----- | SRRNR |
| <i>FCoV</i> | RYRIVKGRKELAEERWFFYFLGTGPHADAKFKDKI | ----- | DGVFWVARDGAMNKPT | ----- | TLGTRGTNNES-KPLRFDGK | ----- | IPPQFQLEVNQ | ----- | SRNNSR | ----- | SGSQR | ----- | SVSRNR |
| <i>NL63-related</i> | RWRMRKGQRVDIDPKVHFYFLGTGPRADLKFRERA | ----- | EDVVWVAMQGSKTEPT | ----- | NLGNRKRNPQK-IQPEFDIQ | ----- | LPNELEVVEFE | ----- | DRSNSS | ----- | SRASSR | ----- | SGN |
| <i>HKU2</i> | RWRMQKGRKQDQPSNWHFYFLGTGPHADAPFRKRI | ----- | QGVHVVAVDGAKTSP | ----- | GLGVRNRNKEP-ATPQFGFQ | ----- | LPADVTVVEAT | ----- | SRSASR | ----- | SRSR | ----- | NRNSQ |
| <i>BtCoV512</i> | RWRMRRGDRVDLPSNWHFYFLGTGPHSDLPFRKRT | ----- | DGVFWVAIDGAKTQPT | ----- | GLGVRKSSEK-LVPKFKNK | ----- | LPNNVEIVEPT | ----- | TPNNSR | ----- | ANSR | ----- | SRSGQS |
| <i>Porcine-EDV</i> | RWRMRRGERIEQPSNWHFYFLGTGPHGDLRYRTRT | ----- | EGVFWVAKEGAKTEPT | ----- | NLGVKASEK-IIPKFSQ | ----- | LPSVVEIVEPN | ----- | TPPASR | ----- | ANSR | ----- | SRSGNGN |
| <i>BtNv-AlphaCoV</i> | RWRMVKGTRKDLPSKWHFYFLGTGPHADLKFRQRQ | ----- | QGVFWVAKEGAKAEPT | ----- | GLGTRGRNAEL-TTPIFNPG | ----- | LPDSIEIVDQY | ----- | SRPNSR | ----- | ASSR | ----- | SRARSQ |
| <i>BtMr-AlphaCoV</i> | RWRMQRGERVEKPSYWHFYFLGTGPHADAKFRERI | ----- | PGVWVSKANADLNPT | ----- | NLGTNRKARSV-ITPKFDSE | ----- | LPDSIEIVDKS | ----- | SAPNSR | ----- | GNRS | ----- | SRQSRG |
| <i>Bat-CoV-1A</i> | RWRMNKGQRKDLPSNWHFYFLGTGPHADLKFRERQ | ----- | VGVFWVAKQGSKTEPT | ----- | NLGTNRNRNQL-RIPEFDFT | ----- | LPDSLEVNSD | ----- | SRPASR | ----- | SDSR | ----- | SRQSKSN |
| <i>Mink-CoV</i> | RWRMQKQKIQLPsrwffYFLGTGPHQNAKFQERI | ----- | DGVYVWVGKNGSKTVPT | ----- | GLGTRGSNQES-LDLQFDCA | ----- | VPSEFKLEQNV | ----- | N | ----- | SRNSR | ----- | SRSRGR |
| <i>LuchengRn-CoV</i> | VYQVRRGKRVPPLPVWYFYFLGTGPHANAAYGTAM | ----- | DGVFWVKTNGQIDPKSTKALGVRDSDGTD | ----- | RRANI-PN-LPEGLRVNVPNASR | ----- | QSRQSQ | ----- | QTSR | ----- | QTSR | ----- | ASSVSRNG |
| <i>BtRf-AlphaCoV</i> | RYRMVGRTRKDLPSKWHFYFLGTGPHAEAKFRRT | ----- | EGVFWVAVQGSKTEPT | ----- | GLGTRKRNAEL-VNPEFAIQ | ----- | LPAAIEIVTQ | ----- | GNSR | ----- | SSQ | ----- | NRDRS |
| <i>HKU10</i> | RWRMVKGQRKELPSKWHFYFLGTGPHQEDARYRQRI | ----- | EGVFWVAVQGSKTDPT | ----- | GLGTRKRQDL-ISPKEFAVK | ----- | IPSNMIVEET | ----- | SRPPSR | ----- | SRSR | ----- | SRPQSR |
| <i>CDPHE15</i> | RWRMRKGQRVDVASKWHFYFLGTGPHSEEQYRKRI | ----- | DGVYVWVAVNGAKTSP | ----- | GLGTRSAKTKP-LELKFNTK | ----- | IPKEVEFVEPT | ----- | SPGSSR | ----- | ANSR | ----- | SRSGGSK |
| <i>Ferret-CoV</i> | RYRIQRGQKVELPDRWFFYFLGTGPHSNAKFKDRI | ----- | DGVFWVGKNGAKTVPT | ----- | GLGTRGTNQES-LDLKFDGN | ----- | VPNDFKLEQNV | ----- | G | ----- | SRNNSR | ----- | SRSRGR |
| <i>HKU8</i> | RWRMRKGQRQNLPSNWHFYHGTGPHADAKFREKI | ----- | QGVFWVAKQGSKVAPT | ----- | DLPTRKRNPQPT-IEPQDFD | ----- | LPKNIEIVTAP | ----- | SQPNSR | ----- | NSR | ----- | SRSSGG |
| <i>NL63</i> | RWRMRRGQRVDLPPKVHFYFLGTGPHKDLKFRQRS | ----- | DGVVWVAKEGAKTVNT | ----- | SLGNRKRNPQK-LEPKFSIA | ----- | LPPELSVVEFE | ----- | DRSNSS | ----- | SRASSR | ----- | SRSTRNN |
| <i>229E</i> | RFTRKGRVDLSPKLHFYFLGTGPHKDAKFRERV | ----- | EGVFWVAVDGAKTEPT | ----- | GYGVRKNSP-EIPHFNOK | ----- | LPNGVTVAEEP | ----- | SRAPSR | ----- | SRSR | ----- | SRSR |

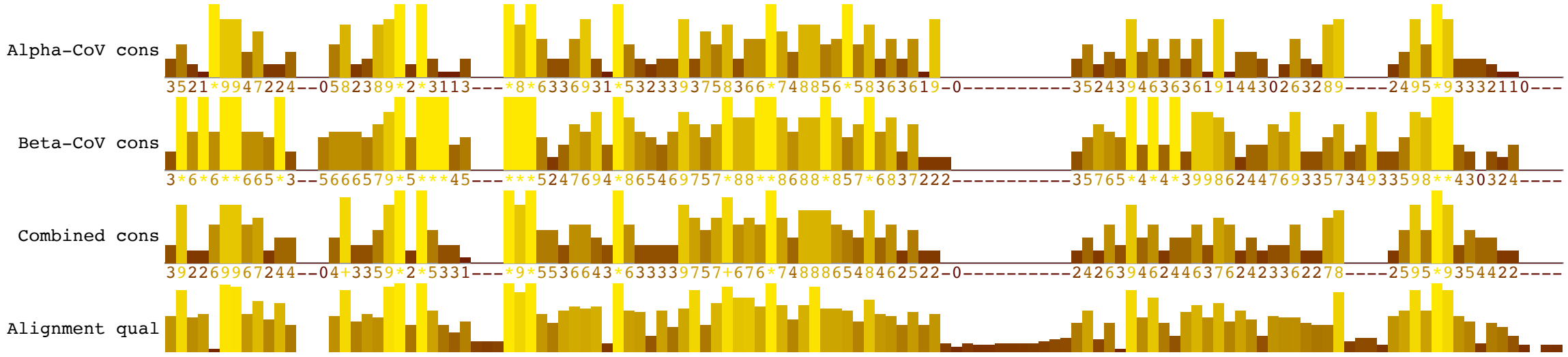


| | 260 | 270 | 280 | 290 | 300 | 310 | 320 | 330 | 340 | 350 | 360 | 370 | 380 | | | | | | | | | | | | |
|---------------|-----|-----|-----|-------------|--|--------------------------------|-------------------|------------|---------------|-------------|---------------|----------------|------------|------------------|------------|------------|--------|-------|----------------|----------------|-----------------|-----------|----------|---------|---------|
| MHV | A | | | RSSSNQRQ | PASTVKPDMA | EEIAALVLAKLG | | K | DAG | | QPKQ | VTK | Q | SAKEVRQKIL | | | | | | | | | | | |
| HKU14 | S | | | RANS | GTRTPTSGVTPDMA | DQIASLVLAKLG | | K | DAT | | KPOQ | VTK | Q | TAKEVRQKIL | | | | | | | | | | | |
| GCCDC1 | S | | | RANS | RASSPGRNLPQAGSEPWMAYLVQKLAQLESKVDGKKPE | K | S | | | | TPOK | VTK | Q | GAANMA | | | | | | | | | | | |
| Hedgehog-CoV | P | | | GSRS | HSPGSVGP | SDASALLYLELAKRLEALEAGKS | K | S | | | APKV | ITK | K | DAADAK | | | | | | | | | | | |
| Bat-BCoV | S | | | SSPGRGLPPA | TDPN | GVLAALLLTKLEALDAKVNGPK | | | | | QPPV | VTK | K | TAAEIA | | | | | | | | | | | |
| Rat-CoV | A | | | RSSSNQRQ | PASTVKPDMA | EEIAALVLAKLG | | K | DAG | | QPKQ | VTK | Q | SAKEVRQKIL | | | | | | | | | | | |
| HKU24 | S | | | RNNS | ASRNNTSEVTPDMA | DQIASLVLAKLN | | K | ESG | | KPVQ | VTK | Q | TAKEIKQKIL | | | | | | | | | | | |
| SARS-CoV | | | | SSRGNS | PARMASGGGE | TALALLLLDRLNQLESKVGKGGQ | Q | | | | QGQT | VTK | K | SAAEAS | | | | | | | | | | | |
| HKU9 | S | | | RASSRGAS | PRPAA | NPSTEPWMAYLVQKLERLESQVSGTKPATK | | | | | NPVQ | VTK | N | AAAANA | | | | | | | | | | | |
| HKU5 | S | | | NNSSRN | ASPAPHGVDVVGAGTLSVLLDLQKRLADLEAGK | G | N | K | | | QPKV | ITK | K | DAQAAK | | | | | | | | | | | |
| HKU4 | S | | | TSNSRGT | SPVSHGVGSAESLAALPLLLDLQKRLADLESGKS | | K | | | | QPKV | VTK | K | DAAAAK | | | | | | | | | | | |
| Bovine-CoV | S | | | RANS | GNRTPTSGVTPDMA | DQIASLVLAKLG | | K | DAA | | KPOQ | VTK | Q | TAKEIRQKIL | | | | | | | | | | | |
| Covid-19 | | | | SSRGT | SPARMAGNGGD | AALALLLLDRLNQLESKMSGKGGQ | Q | | | | QGQT | VTK | K | SAAEAS | | | | | | | | | | | |
| HKU1 | S | | | RSNSNFRHSDS | IVKPDMA | DEIANLVLAKLG | | K | DS | | KPOQ | VTK | Q | NAKEIRHKIL | | | | | | | | | | | |
| MERS-CoV | S | | | GNSTRGT | SPGPSGIGAVGGD | LLYLDLNLRLQALESGKVKQ | S | | | | QPKV | ITK | K | DAAAAK | | | | | | | | | | | |
| OC43 | S | | | RANS | GNRTPTSGVTPDMA | DQIASLVLAKLG | | K | DAT | | KPOQ | VTK | H | TAKEVRQKIL | | | | | | | | | | | |
| TGE | | | | | | FN | NKKD | SVEQAVLAAL | KKLGV | DTE | KQQRSRSR | SKSKERSNS | | KTRD | TPPKNE | | | | | | | | | | |
| FCoV | | | | | | SN | NQ | NNN | VEDTIVAVLEKLG | VTD | KQRSRSK | PRERSDS | | KPRD | TPPKNA | | | | | | | | | | |
| NL63-related | | | | SRDNS | | RSPSR | SRSNS | TSESS | QNSAQDLVA | AVTAALKNLGF | PEPKSDK | | SGNASGT | STPKGKKKPKQAKSNE | QGSP | NNVPSDKSQM | | | | | | | | | |
| HKU2 | | | | QT | | PRVQ | Q | SSQAV | DIVA | AVKQALADLGI | ASSQSKSQSGK | NT | PKPRS | RA | VS | PAPAPK | PARKQM | | | | | | | | |
| BtCoV512 | | | | SRGNSQNR | | GDKSR | NQSRNRSQS | NDRG | SDSR | DLVA | AVKKALEDLGVGA | AKPKGK | | TQSG | KNTPKN | KSR | SGSVQ | RAEAK | | | | | | | |
| Porcine-EDV | | | | QSRGNSQNR | GNN | QGRGASQNR | GNNNNNNKSRNQSNRNQ | S | NDRGG | VTSR | DLVA | AVKDALKSLGIGEN | PDRHKQQQ | KPKQ | EKSDNSG | KNTPKN | KNS | RATSK | ERDLK | | | | | | |
| BtNv-AlphaCoV | | | | SNNRSQSR | GRQNNQNNQPTGDGGSNGQRN | QPRNRSN | SRNRS | SGNQGRN | GGSQ | DLVA | AVREALAGMG | FKPNTSG | | SGRNT | TPVK | | VPKG | D | KPLNKPTKAPASQV | | | | | | |
| BtMr-AlphaCoV | | | | NSRDNSN | NRGKSQS | RNSSRN | RQGQRN | NNQ | QR | QGTGAA | GNGTADLAA | IVLAL | EKAGLTRETE | KAPKKE | SANNNK | SESR | | | ASSPAPAQSKDQL | | | | | | |
| Bat-CoV-1A | | | | S | GTRT | PKNASQ | | | | | NQKPK | KNQ | QEDLVA | AVREALKGLGI | QSR | | SSGK | STP | ARSK | SPARP | SNKKQL | | | | |
| Mink-CoV | | | | | | DN | QSSSQ | IATAVA | AAALQMG | FAPKETQ | KNKSR | SKSR | DRAKS | | | | | | SE | RPVPKNE | | | | | |
| LuchengRn-CoV | | | | | | S | RAPS | V | DRTKEDL | KAVV | SQLLAEMG | ISKNSK | QTONQK | K | | | | | Q | KGSTPAATPHPNQD | | | | | |
| BtRf-AlphaCoV | | | | SQNDQ | KQGNQ | | | NQKSR | SNSQSR | KGNQS | NDSAV | DIVA | AVKQAL | KELGVT | NESNK | | | | KGKNSG | TNPKE | QRS | KSPARS | PTVQKKQL | | |
| HKU10 | | | | SQNN | SRDNS | | | RAPSR | PRSRAN | STSST | TNDAV | DIVA | AVKQAL | KELGVT | PEKKNQEKQK | KS | | | KKSNSG | SNTPE | AAT | PKQKSS | PTPRKQL | | |
| CDPHE15 | | | | KS | | RNSSK | NRGGD | | | NRS | RSSSG | TRDQDA | IVA | AVKAALLGLGLG | TDSNSG | ASGK | ASK | | ANS | GTSTPKPKPA | | | ATPKSP | TPKSQ | |
| Ferret-CoV | | | | | | NN | NSNSG | IATAVA | AAALQMG | FAPKDTQ | KNKSR | SKSR | DRSKS | | | | | | | | | | RE | RPTPNNE | |
| HKU8 | | | | S | | DQK | TPKGSTNNSG | | | SNSQERS | QSKKKGK | STDQ | DLVNA | VRQALMGLGF | QPGNSG | KNGG | KK | | SAPSSG | KSTPKD | | SRSK | | SPARP | QSTKKQL |
| NL63 | | | | | | SRTRS | | D | | S | NQSSD | LVA | AVTLAL | KNLGF | DNQSK | | | | SPSSG | TSTPKKPNKPLSQP | | | | | RADKPSQ |
| 229E | | | | | | RN | | | | PSSDRN | HNSOD | DIMK | AVAAAL | KSLGF | DKPOEK | DKKSA | | | | KTG | TPKSRNOSPASSOSA | AKILARSOS | SETKE | OKHEM | |



390 400 410 420 430 440 450 460 470 480 490 500 510

MHV NKPRQKRTPNKQ--CPVQQCFGKRGPNQ---NFGGSEMLKLGTSDPQFPILAEALPTVGAFFFGSKLELVKK--NSGGADEPTKDVYELQYSGAVRF DSTLPGFETIMKVLNENLNAYQK-DGG--AD
 HKU14 NKPRQKRSPNKQ--CTVQQCFGKRGPNQ---NFGGSEMLKLGTSDPQFPILAEALPTAGAFFFGSRLELAKVQNLSGNADEPKDVYELRYSAGAIRFDSTLSGFETIMKVLNENLNAYQQDDG----
 GCCDC1 DKLRLHKRTPHKG--SGVTQNFGRGPGDLEGNFGDLEMLKLGTDPRFPAAAQMAPATAAFLFMSHFDTREE-----NDATWLNRYGAIKL PKDNPNYATWMKLLKENVDAYKDFPQTP---
 Hedgehog-CoV KMRHHRVATKA--YNPTQAFGLRGPGLDQGNFGLKYCKEGVDDPRWPQMAELAPSASAFLLSMSQLKLVHHSN-----DTDNKPYMLRYSAGAIKLDPKNPYSKWLEILEGNIDAYKDFPKKE---
 Bat-BCoV AKPRQKRVAHKG--YNVNAAAYGRRGPGYQGNFQTEFNKLGTDYPKWQIAQLAPTPSAFFFGMSRFVQKN-----DDGTWLTYPHGHKIMDESDFNFQVWMTLQONIDAYKNFPQKE---
 Rat-CoV NKPRQKRTPNKQ--CPVQQCFGKRGPNQ---NFGGPEMLKLGTSDPQFPILAEALPTGAFFFGSKLELVKK--NSGGVDEPTKDVYELHYSAGAVRF DSTLSGFETIMKVLNENLNAYQNQAGG--VD
 HKU24 NKPRQKRTPNKQ--CTVQQCFGKRGPSQ---NFGGSEMLKLGTSDPQFPILAEALPTAGAFFFGSKLELAKVNNMSGAADEPKDVYELRYSAGAIRFDSTLPGFETIMKVMNENLDAYQHTTEG--AQ
 SARS-CoV KKPRQKRTATKQ--YNVTVQAFGRGPEQTQGNFGDQDLIRQGTDYKHWQIAQFAPSASAFFFGMSRIGMEVT-----PSGTWLTYPHGAIKLDDKDPQFKDNVILLNKHIDAYKTFPPTE---
 HKU9 KKLRLHKRTAHKG--SGVTVNYGRRGPGDLEGNFGDREMILKLGTDPRFAAAAQMAPNVSSFLFMSHLSTRDE-----DDALWLHYKGAIKL PKDDPNYEQWTKILAENLNAYKDFPPTE---
 HKU5 QKMRHHRVATKG--YNVVQAFGMRGPGPLQSNFQDMQYNKLGTEPRWPQIAELAPSASAFMSTSQFKVTHQSN-----DENGEPVYFLSYSGAIKLDPKNPYNNKWEILDANIDAYKSFPKKE---
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 Bovine-CoV NKPRQKRSPNKQ--CTVQQCFGKRGPNQ---NFGGSEMLKLGTSDPQFPILAEALPTAGAFFFGSRLELAKVQNLSGNLDEPKDVYELRYNGAIRFDSTLSGFETIMKVLNENLNAYQQDDGT--MN
 Covid-19 KKPRQKRTATKA--YNVTVQAFGRGPEQTQGNFGDQELIRQGTDYKHWQIAQFAPSASAFFFGMSRIGMEVT-----PSGTWLTYPHGAIKLDDKDPNFQKQVILLNKHIDAYKTFPPTE---
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 MERS-CoV NKMRHHRVATKS--FNMVQAFGLRGPGLQGNFGLQLNKLGTEDPRWPQIAELAPSASAFMSTSQFKLTHQSN-----DDHGNPVYFLRYSAGAIKLDPKNPYNNKWEILLEQONIDAYKTFPKKE---
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 TGE NKHTWKRTAGKG---DVTRFYGARSSSA---NFGDSDLVANGSSAKHYPLAECVPSVSSILFGSYWTS-D-----GDQIEVTFTHKYHLPKDDPKTGQFL----QQINAYARPSEVA---
 FCoV NKHTWKRTAGKG---DVTTFYGARSSSA---NFGDSDLVANGNAACYPQIAECVPSVSSIIIFGSQWSAEF-A-----GDQVKVTLTHTYYLPKDDAKTSQFL----EQIDAYKRPSEVA---
 NL63-related NKPKWKRVPNAS--ENVIKCFGPRDFDH---NMGDADLVQNGVEAKNFPQIAELIPTQAAMFFDSEVSTKE-M-----GNKVQIIYTYKMLVDKDNKHLPKFL----EQVSAFTKPSVVK---
 HKU2 DKPEWKRVPNSE--EDVRKCFGPRSASR---NFGDSDLVQHGVEAKHFPTIAELLPTQAALAFGSEITTKA-A-----GDFVEVYHYVMKVSKTDKNLPRFL----EQVAAYSQPSQIR---
 BtCoV512 DKPEWRRTPSGD--ESVEVCFGPRGGTR---NFGSSEFVAKGVNAPGYAQAASLVPGAAALLFGGNVATKE-M-----ADGVEITYTYKMLVPKDDKLEIFL----AQVDAYKLGDPKP---
 Porcine-EDV DIPEWRRIPKGE--NSVAACFGPRGGFK---NFGDAEFVEKGVDSAGYAQIASLAPNVAALLFGGNVAVRE-L-----ADSYEITYNYKMTVPKSDPNVELLV----SQVDAFKTGNAKL---
 BtNv-AlphaCoV EKPVWKRTPHSQ--ENVEVCFGPRDITYQ---NFGDSDLVRLGVDYPHYPIGELIPSAALLFGSEITAHE-R-----GDNIQLTYIYKMEVPKDHKSLAAFL----PHIGAYADSTED---
 BtMr-AlphaCoV GKVMWKRNPDP--FNVTQCFGPRSVYQ---NFGDEDAIKNGVKAKHFPSWAELTPTPAALLFGSEVITVE-D-----GDDIVIQYNYQMRVPKTMALQTFLL----PQVGAYANGDNES---
 Bat-CoV-1A DKPEWKRVPNRT--ENATTCFGQRSVER---NCGSASVAMGVEAPNFPQIAELIPTQAALFFGSRVSTKE-V-----GDTVEIKYHYKMSVPKTNPNLPYFL----QQVNAYLDPNSDQ---
 Mink-CoV NKHSWKKTGPKG---DVETMFGKRSANS---NFGDAELVKDGSSHKNYPLAEMVPTGALVFGGKWEATE-S-----GDDVIVTVNYSYKLPKNDPKTTAFV----GQIGAYTKPSQVA---
 LuchengRn-CoV GKPVWKKKPNKE--ETVAQCFGPRSDNK---NFGDAEFLRLGVDDPRFKTASYAPGAAASLFDMSMTVSDGP-----DGKKRVTFTHTTIEVDPTKPGFEVFL----AQIDAFKKPATFQ---
 BtRf-AlphaCoV ERPPWKRVPNST--EDVTKCFGVRDTHR---NFGDADLVNRGIDAKHYPLAELVPTPAAVLFGGEVVTTE-V-----GSDVEITYIYKMKVPKTDKNLPAFL----KQVSAYSQPSQA---
 HKU10 ERPEWKRVPNKE--ENVTACFGPRDTHL---NFGDQKLIAGEVQASHYPQLAELVPTPAALLFGGEVSTRE-R-----GDEVEIMYVYKMKVHKSNDKDLPAFL----QQVSAYAQP DAT---
 CDPHE15 ERPEWKRVSD--CSVEQCFGPRGGFK---NFGSADFVQYGAAGYPQAAALTPSAALLFGGNVQVQE-L-----SDDIEITYTYKMTVPKSDKNLEVFL----SNVNAYKEAKPQR---
 Ferret-CoV NKHSWKKTGPKG---EVESMFGKRRPEA---NFGTSDLVNAGSSDKHYPLAELVPGSAALLFGGKWTTKES--DGDVVVTVKYSYTLPKGD-KTTAFL----KQIDAYTKPSDIA---
 HKU8 DKPEWKRVPNKS--ESVTACFGPRDVS---NFGTKGLVAEGVEYSHFPQIAELLPTQAALAFGSRVEVKD-F-----KDEVEIKFHYKMNVPKENKNLQVFL----DQVDAYLDPSREE---
 NL63 KKPRWKRVP TRE--ENVIQCFGPRDFNH---NMGDSDLVQNGVDAKGFQIAELIPNQAALFFDSEVSTDE-V-----GDNVQITYTYKMLVAKDNKNLPKFI----EQISAFTKPSIK---
 229E OKPRWKROPNDVTSNVTQCFGPRDLH---NFGSAGVVANGVKAKGYPOFAELVPSTAAMLFDSHIVSKE-S-----GNTVVLTFTTRVTVPKDHPHLGKFL----EELNAFTREMOO---



| | 520 | 530 | 540 | 550 | 560 | 570 | 580 | 590 | 600 | 610 | 620 | |
|---------------|-------------------|----------------|--------------------|--------------------------|-------------------|--------------------------------------|------------------------|---|-------------------|----------------|-----------------|---------------|
| MHV | VVSPKPQRKRRQAQEK | ----- | KDEVD | ----- | NVSVAKPKSSVQRNVSR | ELTPEDRSLLAQILDDGVVDPG | ----- | ----- | ----- | ----- | LEDDSNV | |
| HKU14 | M-SPKPQRQRGQ | -R | ----- | KGEND | ----- | NISVAVPKSRVQONKSR | ELTAEDISLLKKMDEPYTED | ----- | ----- | ----- | TSEI | |
| GCCDC1 | ----- | ERETKKKKKD | ----- | VVVEDV | ----- | TVVEDVRD | ENGLTDDDWLGA | DDTTIYADENDKPKSQRRRKKREA | AVVETPDV | ----- | ----- | |
| Hedgehog-CoV | ----- | KKQKQSQIKQ | ----- | EAEDPEWDSTDLFSQPLQDPDNQP | ----- | K | A | ORVPKGSITQSRPPKP | ----- | T | VGPMVDVEP | |
| Bat-BCoV | ----- | EKKSRKPKTK | ----- | NVDM | ----- | APQDVM | G | AAAVDLEWDSSIDQSGPNTIVVKPKKQ | ----- | ----- | RKPAADNNISEI | |
| Rat-CoV | VVSPKPQRKRGTQTAQ | ----- | KEELD | ----- | SISVAQPKSAVQRNVSR | ELTPEDRSLLAQILDDGVVDPG | ----- | ----- | ----- | ----- | LDDSNV | |
| HKU24 | L-L-SPKFQRKQ | -KKG | ----- | QVEKD | ----- | NVSAATPKSRVQONVRR | ELTPQDLSILAQIDDDTQG | ----- | ----- | ----- | SSEI | |
| SARS-CoV | ----- | PKKDKKKKTD | ----- | EAQP | ----- | LPQRQK | K | QPTVTLLPAADMDDFSRQLQ | ----- | N | SMSGASADSTQA | |
| HKU9 | ----- | PKKDKKKKKEE | ----- | TAQDTV | ----- | IFEDASTGTDQTVVVKVVKD | QDAQTDDEWLGGE | TVYEDEDDRPKTQRRHKKRGSTASRVTIADPTNAGAERS | ----- | ----- | ----- | |
| HKU5 | ----- | RKQKPSGDDA | ----- | ATAPA | ----- | TSQMEDVPELPPKQQ | R | K | KRVVQGSIPQRSAGVPS | ----- | FE | DVVDIAIFPDSEA |
| HKU4 | ----- | RKPKTTEDGA | ----- | VASSS | ----- | ASQMEDVDAKQQRK | P | KSRVAGSITMRSGSLPA | ----- | LQ | DVTFDS | EA |
| Bovine-CoV | M-SPKPQRQRGQ | -KNG | ----- | QGEND | ----- | NISVAAPKSRVQONKIR | ELTAEDISLLKKMDEPFTED | ----- | ----- | ----- | TSEI | |
| Covid-19 | ----- | PKKDKKKKAD | ----- | ETQA | ----- | LPQRQK | K | QPTVTLLPAADLDDFSKQLQ | ----- | Q | SMSSADSTQA | |
| HKU1 | SLSSKPQRKRGVKQLPE | ----- | QFDSL | ----- | NLS | AGTQHISN | DFTPEDHSLLATLDDPYVEDSV | ----- | ----- | ----- | A | |
| MERS-CoV | ----- | KKQKAPKEES | ----- | T | ----- | DOMSE | PP | K | EQRVQGSITQTRTRPS | ----- | VQ | PGPMIDVNTD |
| OC43 | M-SPKPORORGH | -KNG | ----- | QGEN | ----- | NISVAVPKSRVQONKSR | ELTAEDISLLKKMDEPYTED | ----- | ----- | ----- | TSEI | |
| TGE | ----- | KEQRKRKRSKSA | ----- | ERS | EQDVV | ----- | P | DALIENYTDVFDD | TQVEI | ----- | IDEVTN | |
| FCoV | ----- | KDQRQRSRSKSA | ----- | DKK | PEE-L | ----- | S | VTLVEAYTDVFDD | TQVEM | ----- | IDEVTN | |
| NL63-related | ----- | ETQSHPLQ | ----- | NTMPEPAQLNVAAAEFK | ----- | PPV | TTAS | DGSNAEIEI | ----- | ----- | VDEVLH | |
| HKU2 | ----- | RSQS | ----- | QDDLNVDAFAFT | ----- | PAP | PATPVSARNPDFPE | EEVEM | ----- | ----- | VDEIIN | |
| BtCoV512 | ----- | QRKVKRS | ----- | RTPTPK | ----- | PATEPVYDDVAA | DPTYANLEWDTTVEDG | VEM | ----- | ----- | INEVFDTQN | |
| Porcine-EDV | ----- | QRKKEKK | ----- | N-KRETTLQ | ----- | QHEEAIYDDVGAPSDVTHANLEWDTAVDGGDTAVEI | ----- | ----- | ----- | ----- | INEIFDTGN | |
| BtNv-AlphaCoV | ----- | ----- | ----- | VTLPPALPPKQQLR | ----- | RSA | STEVLA | DTTSVVEEEVEEV | ----- | ----- | VDDVTGQDETFA | |
| BtMr-AlphaCoV | ----- | ESGDQPGASAAAAA | PEPPALPPKLNPKADAFV | ----- | PPKI | ----- | NPNYFDG | MKVEI | ----- | ----- | MNKTI | SDDSTA |
| Bat-CoV-1A | ----- | PIPK | ----- | KP | KAKSEEVQLNPAAPVFT | ----- | PPA | QEPA | ----- | VELEM | VDEVFDIDPLGDSVA | |
| Mink-CoV | ----- | KEQRSRS | ----- | KSR | ERAATPVPTP | ----- | V | SATAENYTDVFDE | ----- | NVEI | IDELN | |
| LuchengRn-CoV | ----- | QTQNFWENQA | ----- | STONNISEYFR | ----- | GTT | PGAGGSAV | EIETFEM | ----- | ----- | TDET | |
| BtRf-AlphaCoV | ----- | ----- | ----- | AEVPSQLNPTAVAFQ | ----- | PLA | ----- | EDEQ | ----- | VEI | IDQVYGSFDA | |
| HKU10 | ----- | TT | ----- | EKATVQPLLNPTAPDFQ | ----- | PAT | ----- | SEEV | ----- | ----- | IEM | INTVYDSFDA |
| CDPHE15 | ----- | EPKKKKD | ----- | RSSRPPTPAPSAPVAS | ----- | GNAEPIYADVQPQGQTEPV | YENPDQYL | GGVDI | ----- | ----- | VNEVYGNL | PDNSQSTA |
| Ferret-CoV | ----- | KEQRSRS | ----- | KSR | ERPQTPLPSN | ----- | SAETENYTGFEFDE | SVEI | ----- | ----- | IDELN | |
| HKU8 | ----- | KPKEQRKSKE | ----- | KKKEEAPAQLNPAAPVFT | ----- | PPV | ----- | VLPDAVAN | ----- | VEFDM | VDEVIDADHESFA | |
| NL63 | ----- | EMQSQSSH | ----- | VAQ | NTVLNASI | ----- | PES | KPLA | ----- | DDDSAI | IEI | VNEVLH |
| 229E | ----- | ----- | ----- | OPLLNPSALEFN | ----- | PSOTS | ----- | PAT | ----- | VEPVRDEVSIETDI | ----- | IDEVN |

