# Understanding Influenza

# Supplementary Information

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# Personal Communication

Edited text of an e-mail from Prof Douglas Richman (23/4/2024), in response to a question about where the Udorn strain of IAV came from:

Dear Drs. Hutchinson and Amorim,

It’s rare that I get asked about my distant youth, but let me embark on a nostalgia trip. I was a research associate (post-doc) in Bob Chanock’s lab at the NIH where we were trying to develop ts mutants of flu A virus for the purpose of developing a live attenuated vaccine. Administration of a biologic to humans required a rigorous chain of evidence or pedigree that precluded a history of passage in animals or transformed cell lines. Consequently we needed a nasal wash from a human for a primary isolate of a new variant and an acceptable cell substrate, in this case primary bovine kidney cells. Dr. Philip Russell, who was a senior medical investigator for the army in southeast Asia, provided such a sample from an air force base (Udorn) in Thailand, and had it flown to us in Bethesda. As you probably know he became a major figure in arthropod transmitted viruses, especially the field of dengue and its hemorrhagic fever.

Molecular cloning was in the future, and I then biologically cloned a virus from this nasal wash by serial plaque to plaque passage in cell monolayers.

Please let me know if you would like me to elaborate or clarify anything.

With best wishes on your endeavor, Doug Richman

Douglas D. Richman MD

University of California San Diego

Distinguished Professor of Pathology and Medicine (Active Emeritus)

Director, The HIV Institute

Co-Director, San Diego Center for AIDS Research

Florence Seeley Riford Emeritus Chair in AIDS Research

# Sequences Used to Construct an Influenza Virus Phylogeny

On 08/11/17 HA sequences weredownloaded from GISAID using the first complete sequence in each of the categories: Influenza B Victoria, Yamagata; and from the Influenza Research Database, using the first complete sequence, for Influenza A H1-H18, C (HEF), D (HE)

In April 2024 additional sequences were downloaded from NCBI for the HA of an H19 influenza virus and HA/HEF/HEPs ofthe influenza-like viruses, Sturgeon influenza-like virus, Flounder influenza-like virus, Seahorse influenza-like virus, Salamander influenza-like virus, Siamese algae-eater influenza-like virus, Chum salmon influenza-like virus, Cane toad influenza-like virus and Ornate chorus frog influenza-like virus.

Sequences were aligned using Clustal Omega and Newick tree visualised using iTOL (https://itol.embl.de/) as a radial view. Sequences and the Newick tree are below.

>AAA43209.1 hemagglutinin precursor [Influenza A virus (A/WSN/1933(H1N1))]

MKAKLLVLLYAFVATDADTICIGYHANNSTDTVDTIFEKNVAVTHSVNLLEDRHNGKLCKLKGIAPLQLG

KCNITGWLLGNPECDSLLPARSWSYIVETPNSENGACYPGDFIDYEELREQLSSVSSLERFEIFPKESSW

PNHTFNGVTVSCSHRGKSSFYRNLLWLTKKGDSYPKLTNSYVNNKGKEVLVLWGVHHPSSSDEQQSLYSN

GNAYVSVASSNYNRRFTPEIAARPKVKDQHGRMNYYWTLLEPGDTIIFEATGNLIAPWYAFALSRGFESG

IITSNASMHECNTKCQTPQGSINSNLPFQNIHPVTIGECPKYVRSTKLRMVTGLRNIPSIQYRGLFGAIA

GFIEGGWTGMIDGWYGYHHQNEQGSGYAADQKSTQNAINGITNKVNSVIEKMNTQFTAVGKEFNNLEKRM

ENLNKKVDDGFLDIWTYNAELLVLLENERTLDFHDLNVKNLYEKVKSQLKNNAKEIGNGCFEFYHKCDNE

CMESVRNGTYDYPKYSEESKLNREKIDGVKLESMGVYQILAIYSTVASSLVLLVSLGAISFWMCSNGSLQ

CRICI

>ABP49470.1 hemagglutinin [Influenza A virus (A/Albany/1/1958(H2N2))]

MAIIYLILLFTAVRGDQICIGYHANNSTEKVDTILERNVTVTHAKDILEKTHNGKLCKLNGIPPLELGDC

SIAGWLLGNPECDRLLSVPEWSYIMEKENPRDGLCYPGSFNDYEELKHLLSSVKHFEKVKILPKDRWTQH

TTTGGSRACAVSGNPSFFRNMVWLTKKGSNYPVAKGSYNNTSGEQMLIIWGVHHPNDETEQRTLYQNVGT

YVSVSTSTLNKRSTPDIATRPKVNGLGGRMEFSWTLLDMWDTINFESTGNLIAPEYGFKISKRGSSGIMK

TEGTLGNCETKCQTPLGAINTTLPFHNVHPLTIGECPKYVKSEKLVLATGLRNVPQIESRGLFGAIAGFI

EGGWQGMVDGWYGYHHSNDQGSGYAADKESTQKAFDGITNKVNSVIEKMNTQFEAVGKEFSNLERRLENL

NKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRMQLRDNVKELGNGCFEFYHKCDDECMN

SVKNGTYDYPKYEEESKLNRNEIKGVKLSSMGVYQILAIYATVAGSLSLAIMMAGISFWMCSNGSLQCRI

CI

>ALM06006.1 hemagglutinin [Influenza A virus (A/Addis Ababa/1514A07305892N/2013(H3N2))]

MKTIIALSYILCLVFAQKIPGNDNSTATLCLGHHAVPNGTIVKTITNDRIEVTNATELVQNSSIGEICDS

PHQILDGENCTLIDALLGDPQCDGFQNKKWDLFVERSKAYSNCYPYDVPDYASLRSLVASSGTLEFNNES

FNWTGVTQNGTSSACIRRSNSSFFSRLNWLTHLNFKYPALNVTMPNNEQFDKLYIWGVHHPGTDKDQIFL

YAQSSGRITVSTKRSQQAVIPNIGSRPRIRNIPSRISIYWTIVKPGDILLINSTGNLIAPRGYFKIRSGK

SSIMRSDAPIGKCKSECITPNGSIPNDKPFQNVNRITYGACPRYVKQSTLKLATGMRNVPEKQTRGIFGA

IAGFIENGWEGMVDGWYGFRHQNSEGRGQAADLKSTQAAIDQINGKLNRLIGKTNEKFHQIEKEFSEVEG

RIQDLERYVEDTKIDLWSYNAELLVALENQHTIDLTDSEMNKLFEKTKKQLRENAEDMGNGCFKIYHKCD

NACIGSIRNGTYDHNVYRDEALNNRFQIKGVELKSGYKDWILWISFAISCFLLCVALLGFIMWACQKGNI

RCNICI

>ASJ81837.1 hemagglutinin [Influenza A virus (A/American black duck/Alberta/307/2016(H4N8))]

MLSITILFLLIAEVSSQNYTGNPVICLGHHAVPNGTMVKTLTDDQIEVVTAQELVESQHLPELCPSPLRL

VDGQTCDIVNGALGSPGCDHLNGAEWDVFIERPTAVDTCYPFDVPDYQSLRSILANNGKFEFIAEEFQWN

TVKQNGKSGACKRANVNDFFNRLNWLTKSDGNAYPLQNLTKVNNGDYARLYIWGVHHPSTDTEQTNLYKN

NPGRVTVSTQTSQTSVVPNIGSRPWVRGQSGRISFYWTIVEPGDLIVFNTIGNLIAPRGHYKLNSQKKST

ILNTAVPIGSCVSKCHTDRGSITTTKPFQNISRISIGDCPKYVKQGSLKLATGMRNIPEKATRGLFGAIA

GFIENGWQGLIDGWYGFRHQNAEGTGTAADLKSTQAAIDQINGKLNRLIEKTNEKYHQIEKEFEQVEGRI

QDLEKYVEDTKIDLWSYNAELLVALENQHTIDVTDSEMNKLFERVRRQLRENAEDKGNGCFEIFHQCDNN

CIESIRNGTYDHDIYRDEAINNRFQIQGVKLTQGYKDIILWISFSISCFLLVALLLAFVLWACQNGNIRC

QICI

>ADU20361.1 hemagglutinin [Influenza A virus (A/American black duck/Illinois/08OS2688/2008(H5N2))]

MERIVIALAIISVVKGDQICIGYHANNSTEQVDTIMEKNVTVTHAQNILEKEHNGKLCSLKGVRPLILKD

CSVAGWLLGNPMCDEFLNVPEWSYIVEKDNPVNGLCYPGDFSDYEELKHLMSSTNHFEKIQIIPRSSWSN

HDASSGVSSACPYNGRSSFFRNVVWLIKKNNAYPTIKRTYNNTNVEDLLIIWGIHHPNDAAEQTKLYQNS

NTYVSVGTSTLNQRSIPEIATRPKVNGQSGRMEFFWTILKSNDAISFESNGNFIAPEYAYKIVKKGDSAI

MRSELEYGNCDTKCQTPLGAINSSMPFHNVHPLTIGECPKYVKSDKLVLATGLRNVPQRETRGLFGAIAG

FIEGGWQGMVDGWYGYHHSNEQGSGYAADKESTQKAIDGITNKVNSIIDKMNTQFEAVGKEFNNLERRIE

NLNKKMEDGFLDVWTYNAELLVLMENERTLDFHDSNVKNLYDKVRLQLRDNAKELGNGCFEFYHKCDNEC

MESVRNGTYDYPRYSEESRLNKEEIDGVKLESMGTYQILSIYSTVASSLALAIMIAGLSFWMCSNGSLQC

RICI

>AKF34349.1 hemagglutinin [Influenza A virus (A/American black duck/Maryland/07OS2482/2007(H6N8))]

MIAIIVIAILAASGRSDKICIGYHANNSTTQVDTILEKNVTVTHSVELLENQKEERFCKILNKAPLDLRG

CTIEGWILGNPQCDLLLGDQSWSYIVERPTAQNGICYPGTLNEVEELKALIGSGERVERFEMFPKSTWTG

VDTSSGVTQACPYNSGSSFYRNLLWIIKTKSAAYPVIKGTYKNTGNQPILYFWGVHHPPDTNEQNTLYGS

GDRYVRMGTESMNFAKSPEIAARPAVNSQRGRIDYYWSVLKPGETLNVESNGNLIAPWYAYKFVSTNNKG

AVFKSNLPIENCDATCQTIAGVLRTNKTFQNVSPLWIGECPKYVKSESLRLATGLRNVPQIETRGLFGAI

AGFIEGGWTGMIDGWYGYHHENSQGSGYAADKESTQKAIDGITNKVNSIIDKMNTQFEAVDHEFSNLERR

IDNLNKRMEDGFLDVWTYNAELLVLLENERTLDLHDANVKNLYEKVKSQLRDNANDLGNGCFEFWHKCDN

ECIESVKNGTYDYPKYQDESKLNRQEIESVKLENLGVYQILAIYSTVSSSLVLVGLIIAMGLWMCSNGSM

QCRICI

>ALT67799.1 hemagglutinin [Influenza A virus (A/American black duck/Delaware/A00870108/2010(H7N3))]

MNTQILALIACMLIGAKGDKICLGHHAVANGTKVNTLTERGIEVVNATETVETANIKKICTQGKRPTDLG

QCGLLGTLIGPPQCDQFLEFDADLIIERREGNDVCYPGKFTNEESLRQILRGSGGIDKESMGFTYSGIRT

NGATSACRRSGSSFYAEMKWLLSNSDNAAFPQMTKSYRNPRNKPALIIWGVHHSGSATEQTKLYGSGNKL

ITVGSSKYQQSFTPSPGARPQVNGQSGRIDFHWLLLDPNDTVTFTFNGAFIAPDRASFFRGESLGVQSDV

PLDSGCEGDCFHSGGTIVSSLPFQNINPRTVGKCPRYVKQTSLLLATGMRNVPENPKTRGLFGAIAGFIE

NGWEGLIDGWYGFRHQNAQGEGTAADYKSTQSAIDQITGKLNRLIDKTNQQFELIDNEFSEIEQQIGNVI

NWTRDSMTEVWSYNAELLVAMENQHTIDLADSEMNKLYERVRKQLRENAEEDGTGCFEIFHKCDDQCMES

IRNNTYDHTQYRTESLQNRIQIDPVKLNSGYKDIILWFSFGASCFLLLAIAMGLVFICIKNGNMRCTICI

>AEM75966.1 hemagglutinin [Influenza A virus (A/American black duck/Illinois/4119/2009(H8N4))]

MEKFIAIAMLLASTNAYDRICIGYQSNNSTDTVNTLIEQNVPVTQTMELVETEKHLAYCNTDLGTPLELR

DCKIEAVIYGNPKCDIHLKDQGWSYIVERPSAPEGMCYPGSVENLEELRFVFSNAASYKRIRLFDYSRWN

VTSSGTSKACNASTGGQSFYRSINWLTKKKPDTYDFNEGSYINNEDGDIIFLWGIHHPPDTKEQTTLYKN

ANTLSSVTTNTINRSFQPNIGPRPLVRGQQGRMDYYWGILKRGETLKIRTNGNLIAPEFGYLLKGESHGR

IIQNEDIPIGNCHTKCQTYAGAINSSKPLQNASRHYMGECPKYVKKASLRLAVGLRNTPSIEPKGLFGAI

AGFIEGGWSGMIDGWYGFHHSNSEGTGMAADQKSTQEAIDKITNKVNNIVDKMNREFEVVDHEFSEVEKR

INMINDKIDDQIEDLWAYNAELLVLLENQKTLDEHDSNVKNLFDEVKRRLSTNAIDAGNGCFDILHKCNN

ECMETIKNGTYNHKEYEEEAKLERSKINGVKLEENTTYKILSIYSTVAASLCLAILIAGGLILGMQNGSC

RCMFCI

>BAN15811.1 haemagglutinin [Influenza A virus (A/African Stonechat/Vietnam/8/2009(H9N2))]

METASLITILLIATVSNADKICIGYQSTNSTETVDTLTENNVPVTHAKELLHTEHNGMLCATSLGHPLIL

DTCTIEGLIYGNPSCDPLLGGREWSYIVERPSAVNGLCYPGNVENLEELRSLFSSASSYQRIQIFPDTIW

NVSYSGTSKACSDSFYRSMRWLTQKNNAYPIQDAQYTNNQEKNILFMWGINHPPTDTVQTNLYTRTDTTT

SVATEEINRTFKPLIGPRPLVNGLQGRIDYYWSVLKPGQTLRIRSNGNLIAPWYGHILSGESHGRILKTD

LKRGSCTVQCQTEKGGLNTTLPFQNVSKYAFGNCSKYIGIKSLKLAVGLRNVPSRSSRGLFGAIAGFIEG

GWSGLVAGWYGFQHSNDQGVGMAADRDSTQKAIDKITSKVNNIVDKMNKQYEIIDHEFSEVETRLNMINN

KIDDQIQDIWAYNAELLVLLENQKTLDEHDANVNNLYNKVKRALGSNAVEDGKGCFELYHKCDDQCMETI

RNGTYNRRKYQEESKLERQKIEGVKLESEGTYKILTIYSTVASSLVIAMGFAAFLFWAMSNGSCRCNVCI

>AGG83172.1 hemagglutinin [Influenza A virus (A/American black duck/New Brunswick/00471/2010(H10N6))]

MYKIVLVLALLGAVHGLDKICLGHHAVSNGTIVKTLTNEKEEVTNATETVESKSLDKLCMKSRNYKDLGN

CHPIGMVIGTPACDLHLTGTWDTLIERDNSIAYCYPGATVNEEALRQKIMESGGIDKISTGFTYGSSINS

AGTTKACMRNGGNSFYAELKWLVSKSKGQNFPQTTNTYRNTDSAEHLVIWGIHHPSSTQEKNDLYGTQSL

SISVGSSTYQNNFVPVVGARPQVNGQSGRIDFHWTMVQPGDNITFSHNGGLIAPSRVTKLKGRGLGIQSG

ASVDNDCESKCFWKGGSINTKLPFQNLSPRTVGQCPKYVNKKSLLLATGMRNVPEIVQGRGLFGAIAGFI

ENGWEGMVDGWYGFRHQNAQGTGQAADYKSTQAAIDQITGKLNRLIEKTNTEFESIESEFSEIEHQIGNV

INWTKDSITDIWTYQAELLIAMENQHTIDMADSEMLNLYERVRKQLRQNAEEDGKGCFEIYHKCDDNCME

SIRNNTYDHTQYREEALLNRLNINPVKLSSGYKDVILWFSFGASCFVLLAVIMGLVFFCLKNGNMRCTIC

I

>AKF35393.1 hemagglutinin [Influenza A virus (A/American black duck/Maryland/13OS2956/2013(H11N9))]

MKKTLLLAAIIICIQADEICIGYLSNNSTEKVDTIIESNVTVTSSVELVENEHTGSFCSIDGKAPISLGD

CSFAGWILGNPMCDDLIGKTSWSYIVEKPNPINGICYPGTLENEEELRLKFSGVLEFSKFEAFTSNGWGA

VNSGAGVTAACKFGSSNSFFRNMVWLIHQSGTYPVIRRTFNNTKGRDVLMVWGVHHPATLKEHQDLYKKD

SSYVAVGSESYNRRFTPEISTRPKVNGQAGRMTFYWTIVKPGEAITFESNGAFLAPRYAFELVSLGNGKL

FRSDLSIESCSTKCQSEIGGINTNRSFHNVHRNTIGDCPKYVNVKSLKLATGLRNVPAIATRGLFGAIAG

FIEGGWPGLINGWYGFQHRNEEGTGIAADKESTQKAIDQITSKVNNIVDRMNTNFESVQHEFSEIEERIN

QLSKHVDDSVIDIWSYNAQLLVLLENEKTLDLHDSNVRNLHEKVRRMLKDNAKDEGNGCFTFYHKCDNEC

IEKIRNGTYDHKEFEEESKLNRQEIEGVKLDSNGNVYKILSIYSCIASSLVLAAIIMGFILWACSNGSCR

CTICI

>AGG84126.1 hemagglutinin [Influenza A virus (A/American black duck/New Brunswick/00998/2010(H12N6))]

MEKFIILSTVLAVSFAYDKICIGYQTNNSTETVNTLIEQNVPVTQVEELVHGGVDPVLCGTELGSPLVLD

DCSLEGLILGNPKCDLYLNGREWSYIVERPKEMEGVCYPGSIENQEELRSLFSSIKKYERVKMFDFTKWN

VTYTGTSKACNNTSNKGSFYRSMRWLTLKSGQFPVQTDEYKNTRDSDIVFTWAIHHPPTSNEQVQLYKNP

DTLSSVTTDEINRSFKPNIGPRPFVRGQQGRMDYYWAVLKPGQTVKIQTNGNLIAPEYGHLITGKSHGRI

LKNNLPVGQCVTECQLNEGVMNTSKPFQNTSNHYIGKCPKYIPSGSLKLAIGLRNVPQIQNRGLFGAIAG

FIEGGWPGLVAGWYGFQHQNAEGTGIAADRDSTQKAIDNMQNKLNNVIDKMNKQFEVVSHEFSEVESRIN

MINSKIDDQITDIWAYNAELLVLLENQKTLDEHDANVRNLHDRVRRVLRENAIDTGDGCFEILHKCDNNC

MDTIRNGTYNHQEYEEESRIERQKINGVKLEENSTYKILSIYSSVASSLVLLLMIIGGFIFGCQNGNVRC

TFCI

>ACV86830.1 hemagglutinin [Influenza A virus (A/black headed gull/Mongolia/1766/2006(H13N6))]

MDIPVVAFLMLTSICVKADRICVGYLSTNSSEKVDTLLENNVPVTSSVDLVETNHTGTYCSLSGISPVHL

GDCSFEGWIVGNPACATNLGIREWSYLIEDPSAPHGLCYPGELDNNGELRHLFSGIRSFSRTELIAPTSW

GEVNDGVSSACKDKGASSFYRNLVWFVKRGNTYPVIRGVYNNTTGRDVLVIWGIHHPVSTDEARQLYAKD

NPYTLVSTSSWSRKYNLETGVRPGYNGQKSWMKIYWYLMHPGESISFESNGGLLAPKYGYIIEEYGKGRI

FQSRIRIAKCNTKCQTSVGGINTNKTFQNIERNALGDCPKYIKSGQLKLATGLRNVPAISNRGLFGAIAG

FIEGGWPGLINGWYGFQHQNEQGVGMAADKESTQKAIDQITTKINNIIEKMNGNYDSIRGEFSQVEQRIN

MLADRIDDAVTDVWSYNAKLLVLLENDKTLDMHDANVRNLHDQVRRVLRTNAIDEGNGCFELLHKCNDSC

METIRNGTYNHTEYEEESKLKRQEIEGIKLKSDDSVYKALSIYSCIASSIVLVGLILAFIMWACSSGNCR

FNICI

>AHJ57334.1 hemagglutinin [Influenza A virus (A/blue-winged teal/Guatemala/CIP049H105-15/2011(H14N3))]

MISFIVIALALSHTTYSQITNGSTGNPVICLGHHAVENGTYVKTLTDNQIEVVSAKELVETNHIDELCPS

PLKLVDGQDCDLINGALGSPGCDHLQDTTWDVFIERPTAMDTCYPFDVPDYQSLRSILASSGSLEFIAEQ

FTWNGVKVDGSSSACLRGGRNSFFTRLNWLTKATNGNYGPINVTKENTGSYVRLYLWGVHHPSSDTEQTD

LYKVATGRVTVSTRSDQISIIPNIGSRPRVRNQSGRISIYWTLVNPGDSIIFNSIGNLIAPRGHYKISKS

TRSTVLRSDKKIGSCTSPCITDKGSIQSDKPFQNVSRIAIGNCPKYVKQGSLMLATGMRNIPDKQTKGLF

GAIAGFIENGWQGLIDGWYGFRHQNAEGTGTAADLKSTQAAIDQINGKLNRLVEKTNEKYHQIEKEFEQV

EGRIQDLEKYVEDTKIDLWSYNAELLVALENQHTIDVTDSEMNKLFERVRRQLRENAEDQGNGCFEIFHQ

CDNNCIESIRNGTYDHNIYRDEAINNRIKINPVNLTMGYKDIILWISFSMSCFVFVALILGFVLWACKNG

NIRCQICI

>AQY17977.1 hemagglutinin [Influenza A virus (A/duck/Bangladesh/24697/2015(H15N9))]

MNTQIIAILALGLSVVKSDKICLGHHAVANGTKVNTLTEKGVEVVNATETVETTSINKVCTKGRKAVDLG

FCGILGTIIGPPQCDLHLDFKADLIIERRNSSDTCYPGKFSNEEALRQIIRESGGIDKETMGFRYSGIRT

DGVTSACKRTGSSFYSELKWLLSSRSNQVFPQLNQTYKNTRKEPALIVWGIHHSSSLEEQNQLYGTGNKL

ITVGSSKYQQSFSPSPGARPKVNGQAGRIDFHWMLLDPGDTVTFTFNGAFIAPDRASFLRSNALSGVEYN

GKSLGIQSDAQLDDSCEGECFYSGGTINSPLPFQNIDSRAVGKCPRYVKQSSLPLALGMKNVPEKTHTRG

LFGAIAGFIENGWEGLIDGWYGFRHQNAQGQGTAADYKSTQAAIDQITGKLNRLIEKTNQQFELIDNEFT

EVEQQIGNVINWTRDSLTEIWSYNAELLVAMENQHTIDLADSEMNKLYERVRRQLRENAEEDGTGCFEIF

HRCDDQCMESIRNNTYNHTEYRQESLQNRIMIDPVKLNSGYKDVILWFSFGASCFVLLAIAMGLIFMCVK

NGNLRCTICI

>ACV86820.1 hemagglutinin [Influenza A virus (A/black headed gull/Mongolia/1756/2006(H16N3))]

MMVKLLYFLIIVFGRYSKADKICIGYLSNNSTDKVDTLTENGVPVTSSVDLVETNHTGTYCSLNGVSPVH

LGDCSFEGWIVGNPSCATNINIREWSYLIEDPNAPHKLCFPGELDNNGELRHLFSGVNSFSRTELINPSK

WGNVLDGVTASCLDRGASSFYRNLVWLVKQNGKYPIIKGDYNNTTGRDVLVLWGIHHPDSETTATNLYVN

KNPYTLVSTKEWSKRYELEIGTRIGDGQRSWMKLYWHLMRPGERITFESNGGLIAPRYGYIIEKYGSGRI

FQSGVRVARCNTKCQTSVGGINTNKTFQNIDRNAIGDCPKYIKSGQLKLATGLRNVPSINERGLFGAIAG

FIEGGWPGLINGWYGFQHQNEQGTGIAADKASTQKAIDEITTKINNIIEKMNGNYDSIRGEFNQVEKRIN

MLADRVDDAVTDVWSYNAKLLVLLENGRTLDLHDANVRNLHDQVKRALKNNAIDEGDGCFNLLHKCNDSC

METIRNGTYNHEDYKEESQLKRQEIEGIKLKTEDNVYKILSIYSCIASSTVLVGLILAFIMWACSSGNCR

FSVCI

>AFC35438.1 hemagglutinin [Influenza A virus (A/little yellow-shouldered bat/Guatemala/060/2010(H17N10))]

MELIILLILLNPYTFVLGDRICIGYQANQNNQTVNTLLEQNVPVTGAQEILETNHNGKLCSLNGVPPLDL

QSCTLAGWLLGNPNCDNLLEAEEWSYIKINENAPDDLCFPGNFENLQDLLLEMSGVQNFTKVKLFNPQSM

TGVTTNNVDQTCPFEGKPSFYRNLNWIQGNSGLPFNIEIKNPTSNPLLLLWGIHNTKDAAQQRNLYGNDY

SYTIFNFGEKSEEFRPDIGQRDEIKAHQDRIDYYWGSLPAQSTLRIESTGNLIAPEYGFYYKRKEGKGGL

MKSKLPISDCSTKCQTPLGALNSTLPFQNVHQQTIGNCPKYVKATSLMLATGLRNNPQMEGRGLFGAIAG

FIEGGWQGMIDGWYGYHHENQEGSGYAADKEATQKAVDAITNKVNSIIDKMNSQFESNIKEFNRLELRIQ

HLSDRVDDALLDIWSYNTELLVLLENERTLDFHDANVKNLFEKVKAQLKDNAIDEGNGCFLLLHKCNNSC

MDDIKNGTYKYMDYREESHIEKQKIDGVKLTDYSRYYTMTLYSTIASSVVLGSLIIAAFLWGCQKGSIQC

KICI

>AGX84934.1 hemagglutinin [Influenza A virus (A/flat-faced bat/Peru/033/2010(H18N11))]

MITILILVLPIVVGDQICIGYHSNNSTQTVNTLLESNVPVTSSHSILEKEHNGLLCKLKGKAPLDLIDCS

LPAWLMGNPKCDELLTASEWAYIKEDPEPENGICFPGDFDSLEDLILLVSNTDHFRKEKIIDMTRFSDVT

TNNVDSACPYDTNGASFYRNLNWVQQNKGKQLIFHYQNSENNPLLIIWGVHQTSNAAEQNTYYGSQTGST

TITIGEETNTYPLVISESSILNGHSDRINYFWGVVNPNQNFSIVSTGNFIWPEYGYFFQKTTNISGIIKS

SEKISDCDTICQTKIGAINSTLPFQNIHQNAIGDCPKYVKAQELVLATGLRNNPIKETRGLFGAIAGFIE

GGWQGLIDGWYGYHHQNSEGSGYAADKEATQKAVDAITTKVNNIIDKMNTQFESTAKEFNKIEMRIKHLS

DRVDDGFLDVWSYNAELLVLLENERTLDFHDANVNNLYQKVKVQLKDNAIDMGNGCFKILHKCNNTCMDD

IKNGTYNYYEYRKESHLEKQKIDGVKLSENSSYKIMIIYSTVASSVVLGLIILAAIEWGCFKGNLQCRIC

I

> EPI\_ISL\_282798 hemagglutinin [Influenza B virus (B/Costa Rica/9213/2017(Victoria))]

MKAIIVLLMVVTSNADRICTGITSSNSPHVVKTATQGEVNVTGVIPLTTTPTKSHFANLKGTETRGKLCPKCLNCTDLDVALGRPKCTGKIPSARVSILHEVRPVTSGCFPIMHDRTKIRQLPNLLRGYEHVRLSTHNVINAEDAPGGPYKIGTSGSCPNITNGNGFFATMAWAVPKNDKNKTATNPLTIEVPYICTEGEDQITVWGFHSDNETQMAKLYGDSKPQKFTSSANGVTTHYVSQIGGFPNQTEDGGLPQSGRIVVDYMVQKSGKTGTITYQRGILLPQKVWCASGRSKVIKGSLPLIGEADCLHEKYGGLNKSKPYYTGEHAKAIGNCPIWVKTPLKLANGTKYRPPAKLLKERGFFGAIAGFLEGGWEGMIAGWHGYTSHGAHGVAVAADLKSTQEAINKITKNLNSLSELEVKNLQRLSGAMDELHNEILELDEKVDDLRADTISSQIELAVLLSNEGIINSEDEHLLALERKLKKMLGPSAVEIGNGCFETKHKCNQTCLDRIAAGTFDAGEFSLPTFDSLNITAASLNDDGLDNHTILLYYSTAASSLAVTLMIAIFVVYMVSRDNVSCSICL

> EPI\_ISL\_283126 hemagglutinin [Influenza B virus (B/Paris/1382/2017(Yamagata))]

MKAIIVLLMVVTSNADRICTGITSSNSPHVVKTATQGEVNVTGVIPLTTTPTKSYFANLKGTRTRGKLCPDCLNCTDLDVALGRPMCVGTTPSAKASILHEVRPVTSGCFPIMHDRTKIRQLPNLLRGYEKIRLSTQNVIDAEKAPGGPYRLGTSGSCPNTTSKIGFFATMAWAVPKDNYKNATNPQTVEVPYICTEGEDQITVWGFHSDNKTQMKSLYGDSNPQKFTSSANGVTTHYVSQIGDFPDQTEDGGLPQSGRIVVDYMVQKPGKTGTIVYQRGVLLPQKVWCASGRSKVIKGSLPLIGEADCLHEEYGGLNKSKPYYTGKHAKAIGNCPIWVKRPLKLANGTKYRPPAKLLKERGFFGAIAGFLEGGWEGMIAGWHGYTSHGAHGVAVAADLKSTQEAINKITKNLNSLSELEVKNLQRLSGAMDELHNEILELDEKVDDLRADTISSQIELAVLLSNEGIINSEDEHLLALERKLKKMLGPSAVDIGNGCFETKHKCNQTCLDRIAAGTFNAGEFSLPTFDSLNITAASLNDDGLDNHTILLYYSTAASSLAVTLMLAIFIVYMVSRDNVSCSICL

>BAD24940.1 hemagglutinin-esterase-fusion [Influenza C virus (C/Ann Arbor/1/50)]

MFFSLLLMLGLTEAEKIKICLQKQVNSSFSLHNGFGGNLYATEEKRMFELVKPKAGASVLNQSTWIGFGD

SRTDKSNSAFPRSADVSAKTADKFRSLSGGSLMLSMFGPPGKVDYLYQGCGKHKVFYEGVNWSPHAAINC

YRKNWTDIKLNFQKNIYELASQSHCMSLVNALDKTIPLQATAGVAKNCNNSFLKNPALYTQEVNPSVEKC

GKENLAFFTLPTQFGTYECKLHLVASCYFIYDSKEVYNKRGCDNYFQVIYDSSGKVVGGLDNRVSPYTGN

SGDTPTMQCDMLQLKPGRYSVRSSPRFLLMPERSYCFDMKEKGPVTAVQSIWGKGRESDHAVDQACLSTP

GCMLIQKQKPYIGEADDHHGDQEMRELLSGLDYEARCISQSGWVNETSPFTEEYLLPPKFGRCPLAAKEE

SIPKIPDGLLIPTSGTDTTVTKPKSRIFGIDDLIIGLLFVAIVEAGIGGYLLGSRKVSGGGVTKESAEKG

FEKIGNDIQILRSSTNIAIEKLNDRISHDEQAIRDLTLEIENARSEALLGELGIIRALLVGNISIGLQES

LWELASEITNRAGDLAVEVSPGCWVIDNNICDQSCQNFIFKFNETAPVPTIPPLDTKIDLQSDPFYWGSS

LGLAITAAISLAALVISGIAICRTK

>AGS48812.1 hemagglutinin-esterase [Influenza D virus (D/bovine/Minnesota/628/2013)]

MFLLLATITAITACQAERELICIVQRVNESFSLHSGFGGNVYSMKTEPMTGFTNVTKGASVINQKDWIGF

GDSRTDLTNDQFPASSDVPLAVAKKFRSLSGASLMLSAFGPPGKVDYLYQGCGKEKVFYEGVNWSPEAGI

DCFGSNWTQTKKDFYSRIYEAARGSTCMTLLNSLDTKISSTTATAGTASSCSSSWMKSPLWYAESSVNPG

AKPQVCGTEQSATFTLPTSFGIYKCNKHVVQLCYFVYENKTTFNTFGCGDYYQNYYDGNGNLIGGMDNRV

AAYRGAANAGVKIECPSKILNPGTYSIRSTPRFLLVPKRSYCFDTDGGYPIQVVQSEWSASRRSDNATEE

ACLQTEGCIFIKKTTPYVGEADDNHGDIEMRQLLSGLGNNDTVCVSQSGYTKGETPFVKDYLSPPKYGRC

QLKTDSGRIPTLPSGLIIPQAGTDSLMRTLTPATRIFGIDDLIFGLLFVGFVAGGVAGGYFWGRSNGGGG

GASVSSTQAGFDKIGKDIQQLRNDTNAAIEGFNGRIAHDEQAIKNLAKEIEDARAEALVGELGIIRSLIV

ANISMNLKESLYELANQITKRGGGIAQEAGPGCWYVDSEXCDASCKEYIFNFNGSATVPTLRPVDTKVVI

TSDPYYLGSTIALCLLGLVAIAASVGVIWICCKK

>ON637239.1 Influenza A virus (A/Common Pochard/Kazakhstan/KZ52/2008(H19)) segment 4 hemagglutinin (HA) gene, partial cds

MWKLALVTTFLMLSRPSKADRICIGYQSTNSTDTVNTLIENEVPVTQSKELLHQEHNGLLCSTSKGSPLE

LDKCKIEGVIFGNPECDLLLGGRDWSYIIERDTAQEGICYPGNIENVEELRVLFSSSSSYKRVVMFPDFV

WNVTYTTTSPACSNSFYRNMRWLTQKSNNFPTQEAQFKNRESDPILFMWATHNPSSQSEQEYLYKNLDTT

SSVSTEELHRSFKSTFGPNVAIKGIQGRMSYGWGILKPNQTLKIRTNGNMVVPWYGHLLRGESHGRILKS

AAPLGDCLVECQTEKGGFNASLPFQNISKYAFGNCPKYVRTKSLKLALGMRNVPIKETRGLFGAIAGFIE

GGWPGLVAGWYGFQHYNSEGTGMAADLASTQRAIDKITSKVNNIIDKMNKQYEVIGHEFSEIETRINMIN

DKIDDQIQDIWAYNAELLVLLENQKTLDEHDSNVRNLYERVKRSLGENAIDEGNGCFELLHKCNNSCMDT

IRNGTYSKYQYSEESKLERLRINGIKLESNTVYKVLTIYSTAASSLVLLLGVTAFMVWAMSNGSCKCTIC

I

>DBA45440.1 TPA\_asm: hemagglutinin or Hemagglutinin esterase [Sturgeon influenza-like virus]

MMKVILSILLFVGFVKCDDVCVYRHIHSNTSTRGSELGDGKATIVPGIYGYGMKKMMNLEKDPDSKQPIA

ILGDSRTDPLKLQWNDITSNMQKVRRGASVSGWGIVRWSLSIMGSEGAKLPDYERLEGDASISYVGVNDF

IEATTNPIRVKFQKEFYQTFLDLLSKNLKMTSIVTGGTKISGRAMCTTAGHNVICPVGSQCLYAFSSTGN

ACKGNNVEVQAYGGYTIVFKGLLKVSGDCAVTCNTYSFSKADPSPQKTLRIYSSFCNQAKPCTNTNRDIY

PKWIEDTMGFDVKPFNDNFYPDDGVDGLHGSSKMRKWFGSDQHRGNIWDANCITDMGSTNITEGTIQMGE

VSATTTFGKCPLIFSERVKIPEIPTKYATRHYYDFGPSEKMPGWALVLIGGLFGGPVGGVMGFLASEGGS

VSMKNVDDEIEKRVGPAFATINENFDKQKQINGIIFDSLEKVSQAIRHLSEDQMSLQMEMTAITIITSLS

DFSDQRAGEIKSQLRAFAQKNNLPWDESSGCVKFDYKCDQSCLEGIVNDTIFIDQEVEYGKSLNFTTVEL

GPRSKEKLDFSYQSSIVLIVVVVVMSIIILMMILYMCGCCGCQRSVSSSGTTIKL

>DBA45486.1 TPA\_asm: hemagglutinin/hemagglutinin esterase [Flounder influenza-like virus]

MERILIFALTLSVTLQDKICVHQVDDSSSGTTRASGGLPPPSTMHGILEKTKSLPAVRLVRPTRETWAFTSLETVGLLTMSSSDGLKGSVNNTVVWENTMGTVLPLGKHCSDHWLIRNEVTSHSSGCPASMTASIEGYKTRSRDIISRGDCFSRVPVRTTLTAGSGNKGCFETDCKYHAGMGTSCSAGWAPFGDIEYTWEIDMKRENGVFYNPLIRICILKERGLPNSNFVIQSTDVSSGAKATVISGTTDSITTTFPAAGYDIGVACYSIIGSQAWKGTVFTRGGTYMKPTFAVVSYRRDPSDGRVSEIIPQLTIEPKIALEERVWCKRKDETGYTVYREKGYDPEFTGGNGVCPITRDLSSATLVAGPVIGQYAVEVEKNVEMYTKFGMATGALTEEQAQRMKQPKFIAALIIAITAAIAGFTGGYFLGKYTNGGASIESVTAALKAVDDARLRAVNELAAQTNQRFDRVDNELNILMAGEKRLARSLFDLRMDFVAFELEMAALTHNTLMDEAEKKIFSKMVTSIIKEMPPGMTYDGNGCFHWDENLHSCNQACLDSLADLANSSLNDTFTSGEIKLTQNGLASFQILPAGSPDIIIITLVMVVGLFVVGALGYCCYRIKKRNK

>DBA45494.1 TPA\_asm: hemagglutinin esterase protein [Seahorse influenza-like virus]

MNRCTTAIVLLLALPIVKSAKTVCFQAHVNNSMHTFHGIGGGVMSTEKDPMVKPVTHVTGAVRTSTDWIG

FGDSRTDDLNNFYPAAADVPRAVADQVTAKFDSLSGASWMRSFFGVPGGVDHPYRGCGKEKIFYEGVNWT

PHHSIDCYGRNWTQVKKDFYKELYSQSLQHECLSLTTGIAGVSSSASGAAISIGTGTPCSSSFFANPKWR

FITKPVTCPGTDDEITTTITLPERTSTSVCEDHIISSCWFNVQRFWFMGAACGDYKNLIYTQDGKRVDGV

DFHFSGYPTHAPPTRGTLECKFLKVKPGRYIVKSGTWHLVPDRSICLGKKGDFPLTVVESKWGPSRQSDT

AQEEACAEVPGCRFIPVKNDYVGEADAHHGDEGVRAILGSLGNPNVTCAHANGGTEGDGQYSTTRLEAPT

YGRCPAYLPRERVPELPTGLMIPRSGTDSRVASRQSRIFGLDDLLIGLGILVAGAVAGYYLASHSGGTGE

SATITSSQAANDKLFQDINIVREGTNKAIKEVNSLKAGFTRALSTLQKEIEDAKTEGLLNTLQTLRVLAV

TNISSTLTESMLELANEISRRGNGHVKEISAGCWEVNDQTCGEKCQNAIFHFGEDADIPLIGTIAPPEKL

EAAEGDPFSYASIAIGGVALAMGIASLAISLKNLRG

>QOE76814.1 hemagglutinin [Salamander influenza-like virus]

MGGPLVIGLIILLLKVASTTSATSKICVGAASGEGAHTVKTISHGDVKVTGVRQLTTELTPKPFGKLRGR

AGESMLCPTCTGCEDLDVALATPTCNGQIQPADYRIIHEQFPKKSKCYAALLDETNIRALPNKLKGYKNN

RWIEGPLVNVGGLEGGPYNPNVVSACPDASGASSFYRTLSGITPVSKTEMVLSKVRVPHSCTGNETMVFV

WGFWNQQPDTSQADLGVSVSQMFSSAKQDKVVHYSSRIAGMGPLAEVQMSTGQGGRITMIMETLEPEEEL

TLGYQRGFLPPRGYWCSSSKIPTIRGPKVPSTVESDCLDSHHGGYNKTTPFYTGKRAPSIGNCSLWSKAE

LKVVNGTRARGGPMSRGLWGAITGFFTGGFDGMAQGWLGTSSTGTHGTAVAADFESTKKAVDKINNNLNT

LSRSVEEKLKETGGLMAQLHGEILSVDGKVEDLRADVFAHFIELEVMMANDGILNDETEALQALQMKAKA

QLGPSAVDVGNGCFYVKHVCNQSCVDSISKGNYTPIDYGLPAFETPEVTAANLVGLTTNDILIYYAVAAS

STMLAIAIAGFIMFLVSKGNLRCTVCI

>QOE76806.1 hemagglutinin [Siamese algae-eater influenza-like virus]

MFCILVIACVALVKAETDTVCVGQPTGIANGTVESVTRNSVPVTGAIDLASSSTNGTYCRLNGKPPRTNL

DGSGSCTNAEALLGGNCGPHQLDVSYHIKQPFVMSKCYPLTEETIASLRNGMDHAFGYASLVRVPVGTGS

VGDWGSYTEGTTQSCNFGAGSSFFGNLFWLIPVTKGAISPQKEFTLTAPTNCEKVMVIWGVFGDSTTTWN

NLYGVVTDSVTIELPDGVTKIDAKHGPFPASSTGNPGVAQTGRMQLRASFLNPGDKAVFLYGQGFIAPKN

MWCLTKKIPFVPNGPTGDCDTTCVSDKGSIVKKTPFQQVSKITFGDCPLYNNGSIHLVNGTEVKPKAVHP

APRGLFGAIAGFLEGGWDGMINGWYGYASHSTGSGTAADYASTQKAVSKITDSINSLTKFTNNNFAKAFK

AINVLSTEIGEVNDKVDDLRADVFTNQLKMMVLLENERILNEHDLNVQALVKDTEKMLGPSALKLNGNCF

QIQHKCNETCLSMLSNKTYVDTKFLPQHLIDEIYLGKVTQTLDGKRWQDPLLITVSCVCVVEFIAVMAAT

IYWLVRNGALRITCCL

>QOE76830.1 hemagglutinin [Chum salmon influenza-like virus]

MKYTMTTTILITLLLSMNVYGESDTVCPSTHDGPSVGTIDTLIGPVAVTGVNLITDEVAAGPMCRLNGKP

VLDKLSVDGLCSDVEVALRAPTCNSDDTRVFGYGLVSPLASSTCSALALDNGDIELLVNTIKGFSKRTWV

PINDVGVYGPFTAGNTSTCKDSSGASSFYQSLHWLVPTTKGSDKTWSYSIRNDNCDVAVMAYGVLETDST

TMTNIYGAVSRPTISATSPAGTKTLRAIYTDEQTGGVQPDIVLGNPGSQASRVKVGAKKVLKGRTVNFIY

NNGAFVPKGYWCLNGRTAVLRGTKGNCDAKCVYSGYGSYNGSKATQKSTKIPGLGRCPAYTEQDLRVVNG

TRARTVNERGFFGAIAGLIEGAWSGMINGWFGVSSATEGVKGAASQESTQMAVDGINNGITTLTEKLNDK

LVVIGNHMNHLEEEILELDAKVNDLRADVTSSQISTLVLLTNQGILDGHDRAVSELRRKLFAQLGPSATP

TGDGCFKIVHKCNATCLDDLANNRFVAEKYVPLTWNVSSVIEAATETGVGGWRDPTLIAVAVVQLVTLTG

GVVAILMMVKGRGGRCFC

>QOE76822.1 hemagglutinin-esterase, partial [Cane toad influenza-like virus]

MLLLFLSLMPLALTEKVKICILPRANSSMIKSYGYGGGVFSTGEMPMTALATASPGLVGRLLNNDWIGFG

DSRTDKSLSAYPAISDIPDFPPSNFVSASGGSFFLSMNGVPGNTDFMYSGCSNEKIFYEGVNDYLHPFGC

YMANNTKRNVEFHKLLYKMSLEHKCLSFSTFTSSGRNPGLTISTATGPCGGGWLKNPVWWWDLAVKPTAC

GTENQIRFKLVDAIGLTKCKRHLLQFCYWKYNTKSAFNVDSCGDNYQYLTDSVGTRIAGIDQGVSGYPGG

PDGVNIECTYLELEPGDYVVKSTPRLLLEPTRSICMGTDGGGFVEVYDSPVGGQMSNPIVTEACEGTAGC

IMVKRKTPYSGVFNIDHGDPEARTALRSLLWTNVSCVSDSGLFFSGSGLFTENPIVGTQAGQCPLPASAD

KIPKIPTGLMIPFSGTDSLQKDLTPANKIFGIDDLLGFLIILVVGEGITAGYLWGKKGSGGASVKSTQAG

FDKLGNDIQLLRGDMNRKLGEINNRFQADERAIESLVDLVQQARVEALLAELGIIKSLVIANISSQLTES

LWELSSEITGRAQGLANPTSPGCWEFDDTQCGKECEDYIFHFNGTKPIDPLDPLDTTVKIWGSGEGIALW

VVAGVSLLISLVVSVGVGWLVKKN

>QOE76799.1 hemagglutinin-esterase [Ornate chorus frog influenza-like virus]

MHNPESEQHNDKKLWIRRWSFFKLPNTTESVLCSISRRFIMLLILLALLAQAEAEKITRCITPRVNNTMI

KSYGYGGGVFSSSQVPMTGVATPMKGVVARILDKNWVGFGDSRTDKSLADYPAVSDIPNFPVNNFVSASG

ASMLLSLTGVPGRVDFAYAGCGKEKVFYEGVNDILNNYDCYFHNNTERSLKFHRVLYKMSQESECLAYNR

FVTSGRSSLLAAVASPTCSGTSTQNPVWYMNTAISPSNCGNENVVRFTLTTKTATTECKRHLLQFCYWRY

NLKSGFNRDNCGDNYQYLTDSLGNRIIGFDQSVSGYPGGSDTATILCDYLDLPPGDYVVRSTPRLLLEPT

RSICMGTGDSSVVEVYDSPVGGAISNPVIVEACNSVAGCIMVKRNSTYQGTYNLDHGDPEARRALSYLLW

KNISCISDNGAFISGSGLFTEERMHGSQAGQCPLTAQPKQIPLLPSGLIIPFSGTDSLQRDLVPASRIFG

LDDLLGFLIILVVAEGVTAGYFWGKKSGGGASVESTQAGFDKLGNDIQILRSDMNSRIIEINARFTADEK

AIESVVDLVQQARVEALLAELGIIRSLIIANISSQMTNSLWELSSEITGRAKGLVTPTSPGCWIIDVDVC

DESCQDYVFNFNGTSPIPTVPPIDTTVKIWGSGEGIALWVVAGVSLLISLLVSFGVVFISRKM

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SHILV:0.31247,

(

C\_HEF\_:0.23642,

D\_HE\_:0.23147)

:0.06168)

:0.12470,

(

SILV:0.41074,

FILV:0.40114)

:0.02080)

:0.04280,

(

B\_Victoria\_:0.03631,

B\_Yamagata\_:0.03560)

:0.32327)

:0.05967,

(

(

A/H10:0.17209,

(

A/H7:0.09817,

A/H15:0.09647)

:0.07853)

:0.07592,

(

A/H3:0.18614,

(

A/H4:0.10979,

A/H14:0.11184)

:0.06297)

:0.07478)

:0.04866)

:0.03880,

(

(

(

A/H9:0.15392,

A/H19:0.17286)

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(

A/H8:0.17207,

A/H12:0.17191)

:0.02089)

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A/H11:0.19211,

(

A/H13:0.09722,

A/H16:0.10491)

:0.12141)

:0.03865)

:0.00347,

(

(

A/H17:0.19662,

A/H18:0.19267)

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(

A/H6:0.19295,

(

A/H1:0.17577,

(

A/H2:0.12535,

A/H5:0.11308)

:0.05198)

:0.02256)

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:0.01615);