

Supplemental Table I: List of sequences used for the studied of MHC class I lineages in cartilaginous fish

Sample	Common Name	Specie	Nucleotide Accession Number	Protein Accession Number
Gici-UAA	nurse shark	<i>Ginglimostoma cirratum</i>	AF220063	AAF66110
Gici-UAA-NC1	nurse shark	<i>Ginglimostoma cirratum</i>	AF357922	AAL59854
Trsc-UAA	banded houndshark	<i>Triakis scyllia</i>	AF034351	AAB97352
Sqac-UAA	spiny dogfish	<i>Squalus acanthias</i>	AY150811	AAN77874
Hefr-UAA	horn shark	<i>Heterodontus francisci</i>	AF028559	AAC60349
Raeg-UAA	clearnose skate	<i>Raja eglanteria</i>	KC335152	AGH32767
Rhpr-UAA	shovelnose guitarfish	<i>Rhinobatos productus</i>	KC469286	AGJ01148
Hefr-UBA	horn shark	<i>Heterodontus francisci</i>	AF028558	AAC60348
Rhty-UBA	whale shark	<i>Rhincodon typus</i>	XM_020536967	XP_020392556
Gici-UBA	nurse shark	<i>Ginglimostoma cirratum</i>	AF028557	AAC60347
Xela-UAA	african clawed frog	<i>Xenopus laevis</i>	L20733	AAA16064
Cami-UAA	elephant shark	<i>Callorhynchus milii</i>	JW872001	AFP04519
Gaga-BF2	chicken	<i>Gallus gallus</i>	NM_001031338	NP_001026509
Gaga-BF1	chicken	<i>Gallus gallus</i>	NM_001044683	NP_001038148
MumuH2D	mouse	<i>Mus musculus</i>	M23444	AAA39567
Hosa-HLA-E	human	<i>Homo sapiens</i>	NM_005516	NP_005507
HosaHLA-A	human	<i>Homo sapiens</i>	U18930	AAA87076
Lach	coelacanth	<i>Latimeria chalumnae</i>	NW_005819663	XP_014346882
Pran	lungfish	<i>Protopterus annectens</i>	GQ485578	ACV87433
Acsi	chinese sturgeon	<i>Acipenser sinensis</i>	GQ485582	ACV87437
Leoc	spotted gar	<i>Lepisosteus oculatus</i>	XM_015339735	XP_015195221
Gaac-U	stickleback	<i>Gasterosteus aculeatus</i>	nd	ENSGACG00000001937
Taru-U	fugu	<i>Takifugu rubripes</i>	NM_001032690	NP001027862
Orni-U	tilapia	<i>Oreochromis niloticus</i>	XM_019355577	XP_019211122
Orla-U	medaka	<i>Oryzias latipes</i>	AB450991	BAJ07290
Cami-UDA	elephant shark	<i>Callorhynchus milii</i>	JW870817	AFP03335
Leer-UDA	little skate	<i>Leucoraja erinacea</i>	LS-transcriptB2-ctg40765*	nd
Rhty-UDA	whale shark	<i>Rhincodon typus</i>	XM_020510579	XP_020366168
Gici-UDA	nurse shark	<i>Ginglimostoma cirratum</i>	MN339476	nd
Prgl-UDA	blue shark	<i>Prionace glauca</i>	GFYY01095694	nd
Scca-UDA	smaller spotted catshark	<i>Scyliorhinus canicula</i>	SSC-transcript-ctg67577*	nd
Leoc-Z	spotted gar	<i>Lepisosteus oculatus</i>	GFIM01040660	nd
Teni-Z	tetraodon	<i>Tetraodon nigroviridis</i>	nd	CAF90807
Dare-Z	zebra fish	<i>Danio rerio</i>	KC607850	AHA37389
Sqac-UCA	spiny dogfish	<i>Squalus acanthias</i>	AF515705	AAN78091
Hosa-CD1	human	<i>Homo sapiens</i>	M28826	AAA51939
Gaga-CD1	chicken	<i>Gallus gallus</i>	AY849319	AAX49405

\*The sequences are obtained from skate database (<http://skatebase.org/>). The remaining sequences are obtained from NCBI (<https://www.ncbi.nlm.nih.gov/>); nd meaning no data



**α3 domain**

nurse shark Gici UAA VKPSVTFSTVRGN-----KQLSCVATGFPYHSIEVNLFRDSAKIDETE---STGVRPNHDGSIYHRSTFEDP---NSQAKYSCVVD---HDGLGQQ-LVVFY  
nurse shark Gici UAA-NC1 .....D.....G.....N.AG.....V.WM.....T.....T.....S.....  
banded houndshark Trsc UAA AA.T.S..RLGDS---K.....Q.....LKH.H..Q.AA.VFY---S.....T.MEKQ.D.E---SDP.F.E.....A.S.H.....  
spiny dogfish Sqac UAA A.R.FPSVKNKASNR-TE..LV...RD...T.L.NGQP.TD.---.IL.....T.LT.WAQITL---DEG.T...QY.Q---G.KV.VE-IRHWD  
horn shark HeFr UAA A.S..RRGDS---NR.....T.....QA...T.R.R.GVSL..SH---FD.IL.....T.T.KW.DI...---AD..F.E.....S.REK-M...  
clearnose skate Raeg UAA LE.E.SIFLSADG---RRV..FT.....R.....V..GLVL.SR---H.TL.....TF.QR.WADVE---GDTTPLL.R.E---P..SEP..E.L.L  
shovelnose guitarfish Rhpr UAA NP.E.S..ASKDG---RR.....Q.....D.TLTL.GRTLE.H---Q.IL...ENT..QT.TVMVE---TD..L.R.E---R.LEP-M..L.L  
horn shark HeFr UBA A.V.S..RFGDS---NR.....V.....QA...T.W.GVM..IL---S.IL.....RT..RKWI.....ED.E...R.E---S.TEM-M..I.I  
whale shark Rhty UBA LS...APIVSTRLGDS-N...LI...QA...T.W.GVL...L---.IL.Y.RT..RKWI.....ED.E...R.E---S.EEK...I.I  
nurse shark Gici UBA .A.T.S..HLGDT---N...LV...QA...T.W.GVV..L---.IL.....RT..RKWI.....ED.E...YME---I.EAK---I.I  
african clawed frog Xela UAA H.H.R.TSDHQADAT---E.R.Q.Y...RE.D.KWVRKNGDDVHS.A--AKEIL.P...LRVTA.IT...EGDS.A.H.E---S.NEK-I.V.W  
elephant shark Cami UAA R.E..L.S.P..S---R...L.....RA...K.LKNGQILSDE---S.TS..Q.T.LRK.V.IN---TATET..Q.E---SS.TTP-FT.V  
chicken Gaga BF2 ER.E.R.VWVKRKAEDGT---LT...R.H...RP.V.SWLK.G.VRGQDAQ---G.IV..G.T.HTWVITDAQ---GDGD..Q.R.E---AS.P.P-GLYSV  
chicken Gaga BF1 ER.E.R.VWVKRKAEDGT---LT...R.H...RP.V.SWLK.G.VRGQDAQ---G.IV..G.T.HTWVITDAQ---GDGD..Q.R.E---AS.P.P-GLYSV  
human Hosa HLA-E ER.E.R.VWVKRKAEDGT---LT...R.H...RP.V.SWLK.G.VRGQDAQ---G.IV..G.T.HTWVITDAQ---GDGD..Q.R.E---AS.P.P-GLYSV  
human Hosa HLA-A2 DA.KTHM.HHVASDHEA-TL-R.W.L.S...AE.TLTWQ..GETQTDTE--LVET..AG..TF.KWAAVVVPS---GGEQR.T.H.Q---E..PKP..TLRW  
coelacanth Lach U R.Q.KLSDRP.SEKNS-IV.T.MV...H.RA.D.TWI..GETRMDNAH--TD.IL.E.T...KTTI.IGS---DDKRS.A.E...GS.NPK-N.VW  
lungfish Fran U P.A..LLQRKARGAD-TEVL.HV...F.RAV..T.WV..GQDQL.EGVQ-NGE.L.L.Q..TF.LRKILTVS--BEQGRHS...Q...ISFTEK-QNYIW  
chinese sturgeon Acsci U P.A..LLQRKARGAD-TEVL.HV...F.RAV..T.WV..GQDQL.EGVQ-NGE.L.L.Q..TF.LRKILTVS--BEQGRHS...Q...ISD.K-I.KEW  
spotted gar Leoc U ER.Q.SVY.RVSSSQGP-EV-T.L...F.KD.V.H.Q..GQDLQ.DWH--GE.L.L.G...F.VRK.LAVSE-BELRHQ...R.QEPR.IMGSS-ARGT  
stickleback Gaac U ER...SLLQKTPS---SPV..H.....RAALRWK.GEELH.DVD--LGEIL.....TF.MRVDLKLSVPAEDWRH.D.FQ---LS.VDED-I.KL  
fugu Taru U EL...SLLQKTPS---SPV..H.....DRATLSWRKGEELH.DVD--HGEMLL.P..TF.MSVDLKVSSVPEDWSK.K.FQ---LS.AKEI-TTLD  
tilapia Orni U L.L..SLLQKSSS---SSVT.H.....NRA.MVWK.GVELH.GVD--KGEILT.N..TF.MSVDLKVSSVPEDWRH.R.FQ---LS.VDED-I.TRL  
medaka Ori U L.L..SLLQKSSS---SAV..H.....DRA.LLWR..GEE.H.GVE--KQIL..N..TF.MSVDLQPPS--GEMDQR.E.FQ---LS.KNEI-VIKL  
elephant shark Cami UDA ...K..VRALKMNSLG-HR.A.LV...TRDV.TWRHEQDVP..T--N..I.I...ST...TSYDHTS---FH.KDT.C.H.Q---SFPFEG-KT.VC  
little skate Leer UDA AV.D.WY.R.SPDSQK-RV.H.L...F.P.T.NMSW...GRSVAANK--NS..L...T.MRV.LTE---AERREHV.R.W---SSRPEG-M..VW  
whale shark Rhty UDA AV.EANYYTIN.HN---VN.H.LV...K..N.TW.A.GKVPD.H---.IL...T...RVIFQIEH---DDGRN.V.RIE---SS.PAP-KE.LW  
nurse shark Gici UDA AV.EANYYTIN.HN---VN.H.LV...Q..N.TW.A.GKVPD.H---.IL...T...RVIFQIER---DDGRN.V.RIE---SS.PAP-KE.LW  
blue shark Prgl UDA V.E.YYYHTKSSDQQN-LNVH.HV...H.RA.N.SWY..GEPL.SPQ---.IL...TH..RIHFQTKA---GDGRS.V.H.Q---SS.PE..ETPW  
spotted catshark Scca UDA D.D.IVYHTKTLGDQN-VNVH.LV...E.A.N.SWY..GALERPO---.IL...T.TRIYF.TKA---GDSRSHV.H.Q---SS.PFGL-KKPW  
spotted gar Leoc Z P.D.HMFAK.SLTPGQ-LT.T.L...PDVQ.D.Y..GVMLL.KDRVL.S...GAEEYTLQRLKLSLEI-RETDKRS..E.K---SS.KEP-V.RQW  
tetraodon Teni Z P.A.YAL.REA.VKAN-IV.T.M...SSNTI.QIK..GLVTKDD---GD...G.T.KRDQV.IPK---SQKS.T.E.I---ESS.LH-IRKW  
zebra fish Dare Z SR.D.HVFAKIIISGAKLK.T.MV...KDVILTIRKYRTALSDN.VE--S...P.T.LRK..NIYE---K.E.D.Y.A---RT.KEP-IIRKW  
spiny dogfish Sqac UCA SP.V.YYFDRKRPLDSS-VAV..LV...RF...VWQ.NEDFVSGV...P.LL...T...KITLLAA---EDE.E.W.H.T---SS.SET-OTEPW  
human Hosa CD1 ...EAWLS.GPSPGPR-L..V.HVS...KPMW.MM.GEQEQG.Q---LGDIL..ANWTYLRATLDVAD---GEA.GL.R.K---SS.EG.DILLYW  
chicken Gaga CD1 P.MAVVFARTAQAQ--LL.V.RV.S...RP.A.TM.L.GREVPSPALSTGT.L.A.LT..LRSLTLLV---QDGHG.A.R.Q---CS.DRS.L.PW

200 220 240 260

**Connecting/Transmembrane domain**

nurse shark Gici UAA EPKTSMLPVIIIGVVVVIVLVIIVIAVGVVWY  
nurse shark Gici UAA-NC1 EPKTSMLPVIIIGVVVLLQARRLATIQKLLM  
banded houndshark Trsc UAA EPKADSMPLVIIIGVIAVLVLAVALAVGVVLY  
spiny dogfish Sqac UAA GTFPSPGEGTNLGLIVGIVGAVALIALVIGAVW  
horn shark HeFr UAA ERKSSDLPPIIVGVVLAVALVIAVGVVY  
clearnose skate Raeg UAA VRKSSGVMIIVLVLVLAVALAVGVVY  
shovelnose guitarfish Rhpr UAA DKSNSPTIWIIVAVLVLVSVIIVAVGVY  
horn shark HeFr UBA AGLKSDSQIPVTVGVVIVLGLLIVLIVAVAVY  
whale shark Rhty UBA DTKSHSQVPTVIVLGLVGLIIVALVAVGAVKI  
nurse shark Gici UBA DPKSHSQVPTLGIIVFVIGVIGIIAIVAVGAVIY  
african clawed frog Xela UAA PGNKDQNMGMIIIAIAVAVALLVIAVAVGAFY  
elephant shark Cami UAA TGPEVGGPPTLIIIVVVIVLIVAAIIGFVLY  
chicken Gaga BF2 EFPQNLVPIVAGVAVAIAIVVGVGFIIY  
chicken Gaga BF1 EFPQNLVPIVAGVAVAIAIVVGVGFIIY  
human Hosa HLA-E KPASQPTPIVGIAGVLLGVSVGVAAVAV  
human Hosa HLA-A2 EPSSQPTPIVGIAGVLLFVAVITGAVAAV  
coelacanth Lach U APPSGNMVIIIAVIVVVLVLAVALVAVV  
lungfish Fran U VPESGPGIIGVIVGVVLAVALAVIIGVVI  
chinese sturgeon Acsci U DPNMRSDDVPESSSPIGLIAGVIVGVLAVALVIAVGVV  
spotted gar Leoc U PGSDRSSNTAVSCGLTQTITQKAGVGRV  
stickleback Gaac U KDKTRNREKPADSTAVAVLVVIAAVVFP  
fugu Taru U KNGIRTNWKPAGVVRDGEPPSNVIAAVALVLAVALVAVGFLY  
tilapia Orni U DKSEIRTNWGNLSLITVWVAVVLAVALVIAVAFIIY  
medaka Ori U EKAKIRTNWEDSSQMLIIIGVLAVALVIAVLSAFIY  
elephant shark Cami UDA RDAVLWTFGKIATLVCVGLLIVISIVALVFI  
little skate Leer UDA DQGRVPIVWLIPATLILLLCTLGVVYFL  
whale shark Rhty UDA EKGGVVPVIVGICILLLLLIFCIGAVVY  
nurse shark Gici UDA EKGGVVPVIVGICILLLLLIFCIGAVVY  
blue shark Prgl UDA VQSDYAMIVGVVVLVILLAGCVGAFVY  
spotted catshark Scca UDA VKGGRAGLIIGVVVMIILAFVAAAVIY  
spotted gar Leoc Z ERTVWVPPASPPSNLPIVVSVLLVVALVAVGAALAFFA  
tetraodon Teni Z DTDEGNTAVVGVAVGVVVLVIGIGLY  
zebra fish Dare Z DGECQDCSSGTPIGTIFGALIGVLLVAVIGGAVVFLA  
spiny dogfish Sqac UCA VPERSPTRVGVIAAGILGIVAVVCTVTRICT  
human Hosa CD1 RNPTSIGSVLAIIVPSLLLLCLALWY  
chicken Gaga CD1 EDSKWLSAGLALLLAAAVALV

280 300

**Cytoplasmic tail**

nurse shark Gici UAA ---K---AGQKTGYNPAKTSKDKGSSSSSLATA  
nurse shark Gici UAA-NC1 ----GTPPQ-APLPLRGRVCGSCLK  
banded houndshark Trsc UAA ---R..-.....AE...N.S...  
spiny dogfish Sqac UAA -----R.R---.E.KSGYNPANPAERGE...NSSAQA  
horn shark HeFr UAA .....E.....R.E...N.S.N.  
clearnose skate Raeg UAA --HW.TR--PAG.S...T...ERRKK.N.S.P.  
shovelnose guitarfish Rhpr UAA --KK.AGCFSGAKN...T...E...N.S...  
horn shark HeFr UBA ---R.--VTGTS...T...E...N.S.N.  
whale shark Rhty UBA ---G.--G.V.NN.S.TWC--LT-IQT.RHLC  
nurse shark Gici UBA ---C.H.DEVWVTVWCLGHG.MASN...EYIRNGLNSAIIKCVCSGE  
african clawed frog Xela UAA ---R-AGKEDA..TA.ANR.SPP...IV.A  
elephant shark Cami UAA -----.GGK---.T...QACNTM-D...NNSNPPA  
chicken Gaga BF2 ---RRH-AGKKGK...I.PDREG.S...TGSNPSI  
chicken Gaga BF1 ---RRH-AGKKGK...I.PDREG.S...TGSNPSI  
human Hosa HLA-E --IWR..SSG.KGGS.SK.EW..SAQG.-E.HSL  
human Hosa HLA-A2 --MWRR.SSDRKGGS.SQ.AS..SAQG.DV..TACKV  
coelacanth Lach U --MW...---NGG-.SQ.Q.KESSS-DT..DT.PPKV  
lungfish Fran U ---W..-Q-G.AQKN.T.Q.NEGS-DT..DTAP  
chinese sturgeon Acsci U ---W..RQ-G.AQKN.T.Q.NEGS-DT..DTAP  
spotted gar Leoc U --FRAAR---FPV..PCHRLDPGRPT.CVYKDKK.C  
stickleback Gaac U --KVHR.R--NA.RSSAK.SSS.SAS-TD-G.EV.EEINPKP  
fugu Taru U ---R...-GKCTKPKGHSEVKEPLKPNP  
tilapia Orni U KKRTD.R-PPSPAENREVKEQMLPQAEETN.S.HNNREDVSAHSSP  
medaka Ori U KKKNA.R-PPSPVDNKEIQEQL-QPE-NP.A  
elephant shark Cami UDA ---WR.R--YRLRSLCKNTG.EQSS...G.SQESLPLQEFDKLMTSPDSSSTSSSSCVQF  
little skate Leer UDA ---W.NGSGVVKCCSFDKGS.EIENS...G  
whale shark Rhty UDA ---C.H.DEVWVTVWCLGHG.MASN...EYIRNGLNSAIIKCVCSGE  
nurse shark Gici UDA ---W.H.DEVWVTVWCLGHG.MASN...EYIRNGLNSAIIKCVCSGE  
blue shark Prgl UDA ---W.Q.MGSCQCDPFGSVDVSTTG..N..QISSEKIEVEIDRNLLSPGTHSSQNRMTVQEFLLSTPDPGCPRE  
spotted catshark Scca UDA ---DWTNR-QLMK.KFYGLCCGGS-V..G..TSSGSGFVTSSEIIGKSVSPSEKANEAEAGDPLMSGSSSSNSASENVQPLVQHPEMGLPRDQAVEMA  
spotted gar Leoc Z ---HRR.K---ASGSDSSG.P-R..D..DLQNTKGTISNNGVSVPLISNGGQTPQNGGLIPEGVFPVLPV  
tetraodon Teni Z ---MAV..FF---IRKADTSKLL-ASIQVV.PV.TALLPGQASGSSSEDSLVSGEDHQGQKQKHG  
zebra fish Dare Z ----NTRMGWRNAL  
spiny dogfish Sqac UCA ---R..T---AQDQQTQQQPALLIDV..RPMEQPKETGGPSGLLPQPIGV  
human Hosa CD1 --MRRRSYQNI  
chicken Gaga CD1 --RRYR.RQRVDEVRST.LAEHRGTARDGTAAGQYGGCDRETPEDEGRGHI

320 340

Supplemental Figure 2. Amino acid alignment of α3 domain, connecting piece, transmembrane domain, and cytoplasmic tail of MHC class I lineages in cartilaginous fish and other representative vertebrates. Due to the high content of Val and Ile, the connecting piece and transmembrane domain was not aligned. All the designations in this alignment are the same as in supplemental figure 1.