

Frog ID	Spawn	Thx	Metamorphosis	Bleed	Immunizations	Sacrifice/ Harvest
056.262.321	8/10/09	-	9/10/09 to 10/10/09	7/28/11	-	10/7/11
056.263.571	2/10/09	-	3/10/09 to 4/10/09	8/25/11	-	10/7/11
056.271.011	8/10/09	-	9/10/09 to 10/10/09	8/25/11	-	10/7/11
056.282.258	10/2/10	10/13/10	11/2/10 to 12/2/10	5/26/11	-	10/7/11
056.280.606	10/2/10	10/13/10	11/2/10 to 12/2/10	5/26/11	-	10/7/11
056.277.339	5/6/10	5/17/10	6/6/10 to 7/6/10	5/26/11	-	10/7/11
056.106.606	8/10/09	-	9/10/09 to 10/10/10	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
056.259.055	6/3/09	-	7/3/09 to 8/3/09	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
040.080.063	9/8/09	9/18/09	10/8/09 to 11/8/09	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
040.080.105	9/8/09	9/18/09	10/8/09 to 11/8/09	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
040.593.882	8/10/09	-	9/10/09 to 10/10/10	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
056.105.865	8/10/09	-	9/10/09 to 10/10/10	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
040.065.593	9/8/09	9/18/09	9/10/09 to 10/10/10	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11
048.531.048	9/8/09	9/18/09	9/10/09 to 10/10/10	6/6/11	5/3/11, 5/10/11, 5/17/11	6/7/11

**Supplemental Table 1. Timeline of frog manipulations.** After sacrifice, nucleic acid was prepared from non-immunized frog gut contents and lymphocytes were harvested for culture from immunized frogs. Only the last three digits of frog microchip numbers are used in other figures and text.

**Supplemental Table 2. Primers used in PCR.**

Primer Name	For/Rev	Domain	Sequence	Priming Site	Anneal Temp.
XI TCRAcf2	F	TCR $\alpha$ C	5'-TCAATGTATCGCCTCAAAG-3'	SMYRLK	53
XI TCRAcR2	R	TCR $\alpha$ C	5'-CATTCCACAGGACTGAAC-3'	SSVLWN	54
XI TCRdCF	F	TCR $\delta$ C	5'-CACTGAAGCCTCAACAAGGTG-3'	ALKPQQG	61
XI TCRdCR	R	TCR $\delta$ C	5'-GATGCTTGGCTAGGCACTG-3'	QCLAKH	60
XITCRbF1	F	TCR $\beta$ C	5'-CGAACTGACCATGGCTACT-3'	DPWLL	58
XITCRbR1	R	TCR $\beta$ C	5'-CTCATTCTGGTGAGGCTGA-3'	QPHQEV	58
XIB2MF1	F	$\beta_2$ M	5'-AACATTAGTCCCCGGTGG-3'	NISPPVW	60
XIB2MR1	R	$\beta_2$ M	5'-GGGAGACCACATTCCACT-3'	VECVVSH	60
530F	F	rRNAV4	5'-GTGCCAGCMGCGCGG-3'		60
1100R	R	rRNAV6	5'-GGGTTNCGNTCGTTR-3'		60

Families	STO	+/-	SMI	+/-	LIN	+/-	NOR	+/-	THX	+/-
<b>P. ACTINOBACTERIA</b>										
<b>C. ACTINOBACTERIA</b>										
<b>O. ACTINOMYCETALES</b>										
Actinomycetaceae	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.01
Corynebacteriaceae	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.00	0.00	±0.01
Microbacteriaceae	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.01	0.00	±0.00
Nocardioideae	0.00	±0.00	0.01	±0.03	0.00	±0.00	0.00	±0.00	0.01	±0.02
Scytonemataceae	0.01	±0.02	0.00	±0.00	0.00	±0.00	0.01	±0.02	0.00	±0.00
<b>O. LENTISPHAERALES</b>										
Victivallaceae	0.01	±0.01	0.01	±0.01	0.00	±0.00	0.00	±0.01	0.00	±0.01
<b>P. ARMATIMONADETES</b>										
<b>C. ARMATIMONADALES</b>										
Armatimonadaceae (OP10)	0.04	±0.10	0.00	±0.00	0.00	±0.00	0.03	±0.09	0.00	±0.00
<b>P. BACTEROIDETES</b>										
<b>C. BACTEROIDIA</b>										
<b>O. BACTEROIDALES</b>										
Marinilabiaceae	0.03	±0.05	0.00	±0.00	0.38	±0.90	0.02	±0.03	0.26	±0.73
Noctuoidea	0.00	±0.01	0.01	±0.02	0.01	±0.02	0.01	±0.02	0.01	±0.01
Porphyromonadaceae	1.22	±1.27	1.30	±1.91	3.71	±2.43	2.29	±2.20	1.87	±2.24
Prevotellaceae	0.01	±0.02	0.00	±0.00	0.05	±0.07	0.01	±0.02	0.03	±0.06
Rikenellaceae	0.28	±0.40	0.28	±0.32	3.31	±6.65	0.42	±0.40	2.17	±5.52
<b>C. CYTOPHAGIA</b>										
<b>O. CYTOPHAGALES</b>										
Cytophagaceae	0.09	±0.14	0.00	±0.01	0.01	±0.02	0.01	±0.03	0.05	±0.11
Flexibacteraceae	0.05	±0.05	1.00	±1.54	0.82	±1.49	0.29	±0.62	0.95	±1.62
<b>O. FLAVOBACTERIALES</b>										
Flavobacteriaceae	7.44	±12.42	0.01	±0.03	0.08	±0.07	0.80	±2.03	4.22	±10.63
<b>C. FLAVOBACTERIIA</b>										
<b>O. FLAVOBACTERIALES</b>										
Cryomorphaceae	0.00	±0.00	0.00	±0.00	0.01	±0.01	0.00	±0.00	0.01	±0.01
<b>P. CYANOBACTERIA</b>										
<b>O. NOSTOCALES</b>										
Nostocaceae	0.77	±1.14	0.00	±0.00	0.00	±0.00	0.24	±0.66	0.27	±0.82
<b>O. OSCILLATORIALES</b>										
Oscillatoriaceae	1.02	±1.49	0.01	±0.02	0.00	±0.00	0.32	±0.86	0.36	±1.07
Pseudanabaena	0.00	±0.01	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.00	±0.00
<b>O. SYNECHOCOCCALES</b>										
Synechococcaceae	0.00	±0.00	0.01	±0.02	0.00	±0.00	0.00	±0.01	0.00	±0.00
<b>P. DEFERRIBACTERES</b>										
<b>C. DEFERRIBACTERES</b>										
<b>O. DEFERRIBACTERALES</b>										

<b>Deferribacteraceae</b>	0.04	±0.06	0.27	±0.35	0.17	±0.19	0.20	±0.21	0.12	±0.27
<b>P. FIRMICUTES</b>										
<b>C. BACILLI</b>										
<b>O. BACILLALES</b>										
<b>Bacillaceae</b>	0.53	±0.42	0.46	±0.45	0.26	±0.15	0.48	±0.45	0.36	±0.25
<b>Sphingomonadaceae</b>	0.09	±0.13	0.00	±0.00	0.00	±0.00	0.03	±0.08	0.03	±0.08
<b>Thermoactinomycetaceae</b>	0.00	±0.00	0.01	±0.03	0.00	±0.00	0.00	±0.00	0.01	±0.02
<b>O. LACTOBACILLALES</b>										
<b>Aerococcaceae</b>	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.00	0.00	±0.01
<b>Carnobacteriaceae</b>	0.15	±0.16	0.07	±0.09	0.06	±0.08	0.11	±0.15	0.07	±0.07
<b>Enterococcaceae</b>	0.02	±0.04	0.03	±0.04	0.00	±0.01	0.02	±0.03	0.01	±0.03
<b>Lactobacillaceae</b>	0.06	±0.14	0.01	±0.01	0.00	±0.00	0.00	±0.01	0.04	±0.12
<b>Paenibacillaceae</b>	0.00	±0.01	0.02	±0.02	0.01	±0.02	0.01	±0.01	0.02	±0.02
<b>Staphylococcaceae</b>	0.05	±0.06	0.03	±0.03	0.00	±0.00	0.04	±0.05	0.02	±0.02
<b>Streptococcaceae</b>	0.03	±0.05	0.10	±0.10	0.06	±0.06	0.06	±0.08	0.07	±0.07
<b>C. CLOSTRIDIA</b>										
<b>O. CLOSTRIDIALES</b>										
<b>Catabacteriaceae</b>	0.01	±0.02	0.08	±0.11	0.15	±0.14	0.04	±0.05	0.11	±0.15
<b>Clostridiaceae</b>	69.57	±25.71	75.63	±20.75	54.45	±22.38	68.33	±20.65	64.76	±25.81
<b>Eubacteriaceae</b>	0.20	±0.21	1.68	±1.79	2.26	±2.10	1.14	±1.51	1.61	±2.02
<b>Gracilibacteraceae</b>	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.01	0.00	±0.00
<b>Lachnospiraceae</b>	0.12	±0.11	0.36	±0.42	0.37	±0.38	0.38	±0.40	0.18	±0.23
<b>Oscillospiraceae</b>	0.01	±0.01	0.02	±0.05	0.04	±0.07	0.02	±0.04	0.03	±0.06
<b>Ruminococcaceae</b>	0.19	±0.24	1.35	±1.37	2.36	±1.75	1.12	±1.31	1.48	±1.77
<b>Peptococcaceae</b>	0.01	±0.02	0.11	±0.18	0.07	±0.09	0.03	±0.05	0.09	±0.16
<b>Peptostreptococcaceae</b>	0.03	±0.03	0.01	±0.01	0.01	±0.02	0.02	±0.02	0.02	±0.02
<b>Syntrophomonadaceae</b>	0.00	±0.00	0.04	±0.10	0.00	±0.00	0.00	±0.00	0.03	±0.09
<b>O. THERMOANAEROBACTERIALES</b>										
<b>Thermoanaerobacteraceae</b>	0.00	±0.00	0.00	±0.00	0.01	±0.02	0.00	±0.01	0.00	±0.01
<b>C. ERYSIPELOTRICHI</b>										
<b>O. ERYSIPELOTRICHALES</b>										
<b>Erysipelotrichaceae</b>	1.07	±1.09	0.66	±0.69	1.78	±2.63	0.92	±1.00	1.42	±2.16
<b>C. NEGATIVICUTES</b>										
<b>O. SELENOMONADALES</b>										
<b>Veillonellaceae</b>	0.08	±0.14	0.05	±0.07	0.14	±0.12	0.09	±0.12	0.09	±0.10
<b>P. PROTEOBACTERIA</b>										
<b>C. ALPHAPROTEOBACTERIA</b>										
<b>O. CAULOBACTERIALES</b>	0.37	±0.50	0.52	±0.89	0.64	±0.75	0.57	±0.62	0.45	±0.80
<b>O. CAULOBACTERIALES</b>										
<b>Caulobacteraceae</b>	0.01	±0.02	0.00	±0.00	0.01	±0.02	0.01	±0.02	0.00	±0.00
<b>O. RHIZOBIALES</b>										
<b>Bradyrhizobiaceae</b>	0.05	±0.10	0.06	±0.13	0.05	±0.13	0.10	±0.15	0.01	±0.01
<b>Hyphomicrobiaceae</b>	0.00	±0.01	0.00	±0.01	0.00	±0.01	0.00	±0.00	0.01	±0.01

Rhizobiaceae	0.16	±0.25	0.00	±0.00	0.00	±0.00	0.04	±0.12	0.07	±0.19
<b>O. RICKETTSIALES</b>										
Anaplasmataceae	0.00	±0.01	0.00	±0.01	0.00	±0.00	0.00	±0.01	0.00	±0.01
<b>O. RHODOBACTERALES</b>										
Rhodobacteraceae	0.01	±0.02	0.00	±0.00	0.00	±0.00	0.00	±0.00	0.01	±0.02
<b>O. RHODOSPIRILLALES</b>										
Fusobacteriaceae										
<b>O. Sphingomonadales</b>										
Planococcaceae	0.02	±0.02	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.01	±0.02
<b>C. BETAPROTEOBACTERIA</b>										
<b>O. BURKHOLDERIALES</b>										
Alcaligenaceae	0.01	±0.02	0.00	±0.00	0.00	±0.00	0.01	±0.02	0.00	±0.00
Burkholderiaceae	0.13	±0.16	0.00	±0.00	0.00	±0.00	0.03	±0.07	0.06	±0.14
Comamonadaceae	0.18	±0.17	0.02	±0.04	0.00	±0.00	0.02	±0.03	0.12	±0.16
Oxalobacteraceae	0.04	±0.09	0.00	±0.01	0.01	±0.02	0.01	±0.02	0.03	±0.07
<b>O. GALLIONELLES</b>										
Gallionellaceae	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.01
<b>O. HYDROGENOPHILALES</b>										
Hydrogenophilaceae	0.01	±0.01	0.00	±0.00	0.01	±0.03	0.00	±0.01	0.01	±0.02
<b>O. NEISSERIALES</b>										
Neisseriaceae	0.09	±0.16	0.02	±0.05	0.00	±0.00	0.02	±0.04	0.06	±0.14
<b>O. NITROSOMONADALES</b>										
Nitrosomonadaceae	0.00	±0.00	0.00	±0.01	0.01	±0.02	0.01	±0.01	0.00	±0.00
<b>C. DELTAPROTEOBACTERIA</b>										
<b>O. BDELLOVIBRIONALES</b>										
Bdellovibrionaceae	0.00	±0.01	0.02	±0.04	0.01	±0.02	0.02	±0.03	0.01	±0.02
<b>O. DESULFOVIBRIONALES</b>										
Desulfovibrionaceae	0.12	±0.25	1.34	±2.32	3.88	±3.56	1.74	±2.81	1.82	±2.99
Geobacteraceae	0.00	±0.00	0.01	±0.02	0.00	±0.01	0.00	±0.00	0.01	±0.02
<b>O. DESULFUROMONADALES</b>										
Pelobacteraceae	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.00	±0.00	0.00	±0.01
<b>C. GAMMAPROTEOBACTERIA</b>										
<b>O. AEROMONADALES</b>										
Aeromonadaceae	0.18	±0.20	0.01	±0.01	0.00	±0.00	0.05	±0.14	0.07	±0.14
<b>O. ALTEROMONADALES</b>										
Shewanellaceae	0.03	±0.04	0.00	±0.00	0.00	±0.00	0.01	±0.03	0.00	±0.01
<b>O. CHROMATIALES</b>										
Chromatiaceae	0.12	±0.26	0.00	±0.00	0.00	±0.00	0.01	±0.02	0.07	±0.22
<b>O. ENTEROBACTERIALES</b>										
Enterobacteriaceae	7.67	±13.77	1.98	±4.75	1.86	±4.21	6.36	±11.54	1.31	±3.55
<b>O. PSEUDOMONADALES</b>										
Moraxellaceae	0.38	±0.56	0.01	±0.01	0.00	±0.01	0.01	±0.03	0.25	±0.48
Pseudomonadaceae	0.09	±0.09	0.01	±0.02	0.01	±0.02	0.04	±0.07	0.04	±0.07

<b>O. VIBRIONALES</b>										
Vibrionaceae	0.04	±0.06	0.00	±0.00	0.00	±0.00	0.01	±0.03	0.02	±0.05
<b>O. XANTHOMONADALES</b>										
Xanthomonadaceae	0.05	±0.10	0.01	±0.02	0.00	±0.00	0.01	±0.02	0.03	±0.08
<b>P. SPIROCHAETES</b>										
<b>C. SPIROCHAETIA</b>										
<b>O. SPIROCHAETALES</b>										
Spirochaetaceae	0.00	±0.00	0.00	±0.01	0.05	±0.09	0.01	±0.01	0.03	±0.08
<b>P. SYNERGISTETES</b>										
<b>C. SYNERGISTIA</b>										
<b>O. SYNERGISTALES</b>										
Synergistaceae	0.22	±0.32	5.77	±8.19	1.74	±1.14	1.95	±2.06	3.21	±7.07
<b>P. TENERICUTES</b>										
<b>C. MOLLICUTES</b>										
<b>O. ACHOLEPLASMATALES</b>										
Acholeplasmataceae	0.03	±0.06	0.08	±0.09	0.13	±0.19	0.07	±0.08	0.09	±0.16
<b>O. ENTOMOPLASMATALES</b>										
Spiroplasmataceae	0.04	±0.09	0.19	±0.29	0.12	±0.14	0.07	±0.09	0.17	±0.26
<b>O. MYCOPLASMATALES</b>										
Mycoplasmataceae	0.01	±0.01	0.00	±0.00	0.05	±0.13	0.00	±0.01	0.04	±0.10
<b>P. VERRUCOMICROBIA</b>										
<b>C. OPITUTAE</b>										
Opitutaceae	0.01	±0.02	0.00	±0.00	0.00	±0.00	0.00	±0.01	0.00	±0.00
<b>O. PUNICEICOCCALES</b>										
Puniceicoccaceae	0.00	±0.00	0.01	±0.02	0.00	±0.00	0.00	±0.01	0.00	±0.00
<b>C. VERRUCOMICROBIAE</b>										
<b>O. VERRUCOMICROBIALES</b>										
Verrucomicrobiaceae	0.00	±0.01	0.01	±0.02	0.08	±0.16	0.01	±0.02	0.05	±0.13

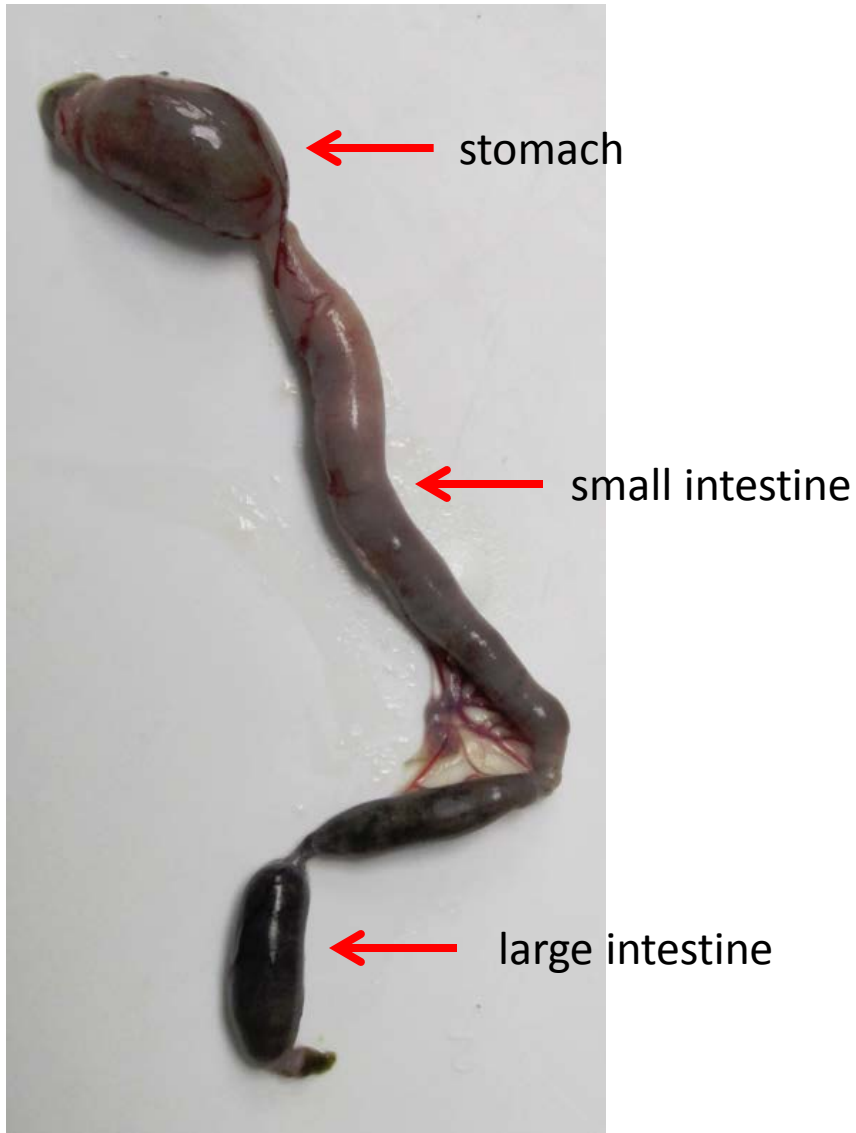
**Supplemental Table 3. Percentage of 16S rRNA gene clones belonging to bacterial families. Averages +/- standard deviation of samples from stomach, small intestine, large intestine, normal (thymus intact) and thymectomized frogs.**

common name	species	tree abbreviation	Ig	C domains	accession #
zebrafish	<i>Danio rerio</i>	T zebrafish	IgT	3	AAT67446.1
rainbow trout	<i>Oncorhynchus mykiss</i>	T trout	IgT	4	AAW66981.1
Iberian ribbed newt	<i>Pleurodeles waltl</i>	M newt	IgM	4	CAE02685
		Y newt	IgY	4	CAE02686
Mexican axolotl	<i>Ambystoma mexicanum</i>	M axolotl	IgM	4	A46532
		X axolotl	IgX	4	CAO82107.1
		Y axolotl	IgY	4	X69492
African clawed frog	<i>Xenopus laevis</i>	M frog	IgM	4	AAH84123
		X frog	IgX	4	S03186
		Y frog	IgY	4	AAH97629
African clawed frog	<i>Xenopus (Silurana) tropicalis</i>	F frog	IgF	2	MGC108125
red-eared slider	<i>Trachemys scripta elegans</i>	M slider	IgM	4	AAB03838
Chinese soft-shelled turtle	<i>Pelodiscus sinensis</i>	M turtle	IgM	4	ACU45376.1
		Y turtle	IgY	4	ACU45374.1
green anole	<i>Anolis carolinensis</i>	M anole	IgM	4	ABV66128
		Y anole	IgY	4	ABV66132
leopard gecko	<i>Eublepharis macularius</i>	M gecko	IgM	4	ABY74510.1
		A gecko	IgX/A	4	ABG72684.1
		Y gecko	IgY	4	ACF60235.1
duck	<i>Anas platyrhynchos</i>	M duck	IgM	4	AAA68605.1
		A duck	IgA	4	AAA68606.1
		Y duck	IgY	4	CAA46322.1
common pheasant	<i>Phasianus colchicus</i>	M pheasant	IgM	4	PMID 20398946
		A pheasant	IgA	4	PMID 20398946
		Y pheasant	IgY	4	PMID 20398946
turkey	<i>Meleagris gallopavo</i>	M turkey	IgM	4	PMID 20398946
		A turkey	IgA	4	PMID 20398946
		Y turkey	IgY	4	PMID 20398946
quail	<i>Coturnix japonica</i>	M quail	IgM	4	PMID 20398946
		A quail	IgA	4	PMID 20398946
		Y quail	IgY	4	PMID 20398946
chicken	<i>Gallus gallus</i>	M chicken	IgM	4	P01875
		A chicken	IgA	4	AAB22614.2
		Y chicken	IgY/G	4	S00390
Australian echidna	<i>Tachyglossus aculeatus</i>	M echidna	IgM	4	AAN33013.1
		A echidna	IgA	3	AAN33012.1
		G echidna	IgG	3	AAM61760.1
		E echidna	IgE	4	AAM45140.1
platypus	<i>Ornithorhynchus anatinus</i>	M platypus	IgM	4	AAO37747.1

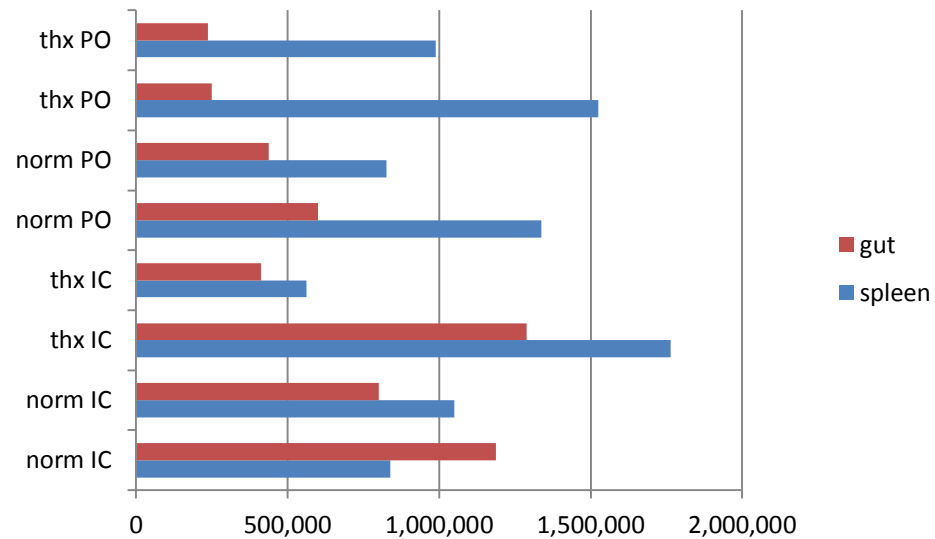
		A1 platypus	IgA1	3	AAL17700.1
		A2 platypus	IgA2	3	AAL17701.1
		Y platypus	IgY/O	4	ACD31541
		G1 platypus	IgG1	3	AAL17703.1
		G2 platypus	IgG2	3	AAL17704.1
		E platypus	IgE	4	AAL17702.1
<b>gray short-tailed opossum</b>	<i>Monodelphus domestica</i>	M opossum	IgM	4	AAD24482.1
		A opossum	IgA	3	AAC48835.1
		G opossum	IgG	3	AAC79675.1
		E opossum	IgE	4	AAC79674.1
<b>brush-tail opossum</b>	<i>Trichosurus vulpecula</i>	E brush-tail	IgE	4	AAF80357.1
<b>mouse</b>	<i>Mus musculus</i>	M mouse	IgM	4	AAB59651.1
		A mouse	IgA	3	AAB59662.1
		G mouse	IgG	3	AAB59656
<b>human</b>	<i>Homo sapiens</i>	M human	IgM	4	CAA33070
		A1 human	IgA	3	AAC82528.1
		G1 human	IgG1	3	AAC82527.1

**Supplemental Table 4. Comparative Ig C regions used for phylogenetic analysis of the relationship between IgX and IgA.** Pheasant, turkey and quail sequences were described in Choi *et al.* (*Veterinary Immunology and Immunopathology* 136: 248-256, 2010) and were kindly supplied by Dr. Jae Yong Han.





**Supplemental Figure 1. Site of flora sampling from *Xenopus laevis* gastrointestinal tract.** Resected alimentary canal from adult *X. laevis* fed one day before tissue harvest. Red arrows show the three sites where luminal contents were harvested.



**Supplemental Figure 2. Total cell counts from tissue harvests.** After sacrifice, lymphocytes were isolated from spleen and intestine as described in Methods. Total cells isolated from each immunized frog are shown, identified by surgery status and immunization route.

10 20 30 40 50 60 70 80 90 100  
M newt .....APSVFPLIG---CGASSDPVVGCLAKD-FLPDSATFTWWDKNNSSFTSG-LANFPSIMTN-SFYTASSKVQVTS-ESWKNKDS--YYC  
M axolotl .....APSVYPLIS---CGASLDPVVGCLAKG-FLPDSVTFDWDKNNASFSAG-VAKLPSVTTG-GLYSASTRVKVPSESWKNRDP--YYC  
M frog .....PPSLFPLIS---CGESMDPVTIGCLAKD-FLPETISFTWGDKNNASYSTG-LKSYKPVMQSSGYSASSQVNVASAVWDKMEP--FYC  
M slider .....ASPAAPSLFPLYP-SCGTDTSQDPIALGCLAKD-FLPETIEFNWSDKNPNITDG-VKKFPSVLNTVGTYSATTQLLVPAS--KAQTI--FYC  
M turtle .....APDLFPLFP-SCGFDPSPVVLGCLAKD-FLPDSITFSWRD-KTSNLITNA-MKNYPSTLNTVGTYSTVTQLSLSAS--KAEGI--FYC  
M anole .....APVLFPLIP-IGSGDGEN--IAIGCLAKD-FLPDSITFAWNPKNATIDDSNIKTFPSISDASGTFMASSQTAVSVTDWKARSA--FYC  
M gecko .....TDSNE--ITIGCMAKD-FLPDSLTLVWQKPNNDLEADKIKRFPSINNPTGTFIASSAATVPTSQWDAFKP--FYC  
M duck .....PTLFPLLS-CSSSSSSSSLYAVGCVAVG-HVPAGVTFVSWT-DVTNATVATT--IVNFPEARPGGNWAASRLELPLQEGKGRQP--FYC  
M pheasant .....GSSSPSAPVLYPLVP-CSPSAS---LYTIGCAAFN-FQPNTISFSWFDSSNRSVTAL--DFGSTFSSGRG-YRATSRLQMTQTEGKQKQP--FRC  
M turkey .....GSTSATAPVLFPLVP-CSPSAT---LYTVGCAAFN-FQPNTISFSWADSSNRSVTAL--NFGSVITSGRG-YRATSRLQMTQTEGKERQP--FRC  
M quail .....GSSSPSPRFLFPLVP-CSPSPS---LYAIGCAAFD-FRPSSISFRWTDNDNETLPAS--DFNPIQAPDMT-YKAVSSFRMTQTEGKSRQP--FRC  
M chicken .....PRLFPLVL-CSPSDS---VYTVGCAAFD-FQPSSIAFTWFD-SNNSSVSGM--DVIPKVISGPP-YRAVSRIQMNQSEGKQKQP--FRC  
M echidna .....SLNQESSLAVGCLAKN-FLPNSITLWDFKNRTTVGTEKFINYPTVLSGQT-YSTTSQMTISATEVMMGQDDFVFC  
M platypus .....APLLFPLVPSCGDSLQESSLAVGCLAKN-FLPNSITLWDFKNRTTVGTEKFINYPTVLSGQA-YSTTSQMLISATEVMMGQDDYVFC  
M opossum .....APNLFSLSP-CLNSGVQNAVAVGCLAKD-FLPDSINFSWTYQNSAISHTDLKIFPSQMSGPT-YTATSQVILPALDVLQDS--YLVC  
M mouse .....PNVFPLVS-CESPLSDKNLVAMGCLARD-FLPSTISFTWNYQNTEVIQG-IRTFPTLRGKG-YLATSQVLLSPKSILEGSDYLVLC  
M human .....GSASAPTLFPLVS-CENSPSDTSSVAVGCLAQD-FLPDSITFSWKYKNNSDISS--TRGFPSVLRGGK-YAATSQVLLPSKDVMOGTDEHVVC  
X axolotl .....APTFFPLIPCCVDRGS-TSPLTLGCLMSGYLP-EPVNVWTWSTGTV---SSVRTPSSAYNAASGLHMRSSQITVPAGSWITG--KYTC  
X frog .....APSVFPLIPCCDNDVF-NDSVTMGCLVTVGYMA-DPLDIQWNDGSIT---TGIKTMRPVLSDVDGLYTLSSQLTLILASEWKNS--TYKC  
A gecko .....APSVFPLPCCQDP---TSNKTMGCLITG-YFPEPATVQWNSG--A--ITSGIQNFPAVRQSSSGTYTFTSQTLPASSLHSQ--TFQC  
A duck .....PTAYPLVT-TTACED-GSNVTIGCLVDFEF-EPVTVWVSGVTG---DQLTFPAVQN--GASYTVSSQLTVPASSYDQG--NFQC  
A pheasant .....VPESGPTLYPLTPYCSHVEG-DTNVTIGFLVTSFIP-PPVSVTCATVGS----PVETTLPVVT--SGGYSLTTAVTLPLEECHT--ELTC  
A turkey .....VPATGPTLYQLLPVPSDCDN-DANVTIGFLVTSFIP-PPVTVTWTTGGSPAG--PALTSLPVLT--SDGYYSFTTALTLVPEETCS--EFTC  
A quail .....DPASGPTLYPLPPSECS---DNVTIGCLVTSFIP-PPVTISWTITGSSLDPTSATTSLPVQT--SGGTYSQTTALVVPMEEVKEG--RFTC  
A chicken .....PTLYQLLPLPSDCP--DPNVTIGCLVTSFLP-PPVTVTWTTGGAADA--TAVTSLPVAT--TGGTYSLTTALTVPREQLQGN--EFVC  
A echidna .....ATKTTPTVFPLSAYQSNSE--DPVSIIGCLVTVGYFP-EPVEVTWN-NQNKDG--STARTFPAVL-ESSGYVLSLLVLPADQCPES--KAYQ  
A1 platypus .....FPLETCSSENQ--DPVVACLKVGIFP-MPGVVYWDSDQAS---SFTRTYNSIQ-STGGSFVFSVQLTMLSSQCPLE--KEFH  
A2 platypus .....APTIFPLNAYGSNSE--EQVSIIGCLVTVGYFP-EPVEVTWV-NQAS---SAVRTYPAVL-ESNGYVLSLMLTLPANQCPDD--KTYQ  
A opossum .....SPTVFPMSLCDSRTG--DSVALGCLAQGFPP-EPVTLVSWNYNGSE---GTVRSYPAML--SGNTYLQTSVLDLTPANQCP--EAYK  
A mouse .....PTIYPLTLPPVLCVCS--DPVLIIGCLVTVGYFPFPTMNVTVGKSGKD---ITTVNFPPAL-ASGGRYTMSQLTLPAVECPPEG--ESVK  
A1 human .....SPKVFPPLSLCSTQPD--GNVVIACLVQGFPPQEPVSVTWSESGQG---VTARNFPPSQDASGDLYTTSSQLTLTPATQCLAG--KSVT  
Y newt .....SKPSVYPLVSCCG-AES-STNVDIGCLATG-YLPEPVTAWDQN-GS--ITSGIRTFPAVRHKSSHYSLSSVLSVSSADWTKT--TYKC  
Y axolotl .....KPSVFPPLVPCCG-STP-DTNVSIIGCLVTVGYFP-EPVVEVSWKAG-ST--TMPGGKTFPAAQQOAT-ALSTSSQIRIPAYEWGTN--SYSC  
Y frog .....APSVFPLRPCCGSSSS-DSHVTIGCLSTG-FLPAPVDVWVNS--GS--ITSGIKNFPAVLQQSG-LFASSSQLTIPLSDWKAKK-SFEC  
F frog .....APSVFPLKPC---SSS-NEIATIGCFASG-FLPQPVNIQWKSSSSGS--ITSGIKNFPAVAQQSG-YFASSSQLTIPIISRWNSE--SFTC  
Y turtle .....APSVFPLTSCPGIAT--TSQVTFGCLVKG-YFPEPVTVQWTP-----NTSGVKDYPVSLQVTSGLYSLSSQVTVSDSSWEDN--TYHC  
Y anole .....TFLAVTSATPTAPAVFPLTPCCQDLA-ASEVRLGCLVTVGYFP-EPVTVQWNSG--A--ISTGIRTFPAVLQSSSGHYTLSSQLTVPVSSWNTI--NFQC  
Y gecko .....APAVFPLSPCCEDTSS-ASQVTMGCLISG-YFPEPATVQWNSG--A--LSSGIQNFPSLLQSSSGHYIFSSQLTVPVSSWQSQ--NFEC  
Y duck .....APSVFPISSCCGSTQ--Q-QPVVGLATG-YIGPVVTFVSW-----GASGATSVTVPEETHGVGPHKRASFLRPPHAGAGD--FFTC  
Y pheasant .....ARPTSSPQLYPLSACCS-DSS--L-PAAVGCLVSPSSSSSSSVWEGV-----GGSDMAAIVS-----GSPKRLSFVRLTAGEKRK--SFVC  
Y turkey .....AGPTGSPQLYPLSACCSGSS--L-PPAVGCLVSP-SVPSAVTWDTG-----GSSEVSWFGS-----GSSKLSFVRLTAGEKRM--SFVC  
Y quail .....ARPQLFPLSACCSSS-----PISLIGCLVSP-SVPSSITWVSGP-----RGSEPGSAIL-----DPQRKLGFIRLRDGDKGE--KFEC  
Y chicken .....ASPTSPRRLYPLSACCSDSA--V-PPAVGCLLSP-SSAGGISWEGS-----GGTAVAGRVS-----GTPVKLSFVRLSPGEKRK--SFVC  
Y/O platypus .....APSVFPLTPSCEEVE--LSEVTLGCLVTVGYFP-EPVVDVWVSWPS--F--YNSKAQTYPSILHP-TGLYSLSSKITVPAYNWHNK--VYTC



Y newt LVKHEPTNTNTDKTVSS-AVC-----KTATSKPAVQVLQSSCDDL DGN SIELICLVSGYSPDKIKVQWLRNGETT---FLPAYTSPSIIKGRE  
 Y axolotl SVKHKPTSTETIHKTTITS-AEC-----KKATSKPSVQVLQSSCADTDGN SIELVCLISGYTPDNIQVRWL VNDKMA---PIQGQTSPPQKDGQ  
 Y frog NVEHKPTSTKVTQKIECQDEP-----EPEPIKPTVEILQGPCASSE--SVELLCLITGYAPSEIKVQWLLNGQVT---EISPSNSKPCKEEN  
 F frog TVTHGSTSTPVTSELKG-----TSCNR--  
 Y turtle TVKHEPTSSSITKEIP-----KSSTPQPPTVQVYHSS-CKLTPG-TIDLLCHVSGFYPTPVTVEWLVDGESG---VLHGETAPATRDAGG  
 Y anole KVIHAPTSSTIEQRIERC-----VTHSPVAPDVRLHSSCSPRSTDASIELVCLISNFYPKEVSVEWLIGGKSG---LLPSYTEPPRQDAVG  
 Y gecko NVEHASTNTTISKEIEAC-----LMHEPVTPEVLLLHSSCNRTDNATIQLVCLISGFYPRTVKVNWL VNRQLA---ILPAHTENPRKDATG  
 Y duck SVNHQATRTSLTQNV EGCVA-----GGEP-TPPEVQVLHSSVCSLGLDSSVELL CVITGFSPPPVEVEWLV DGA PA---HLVATMTRPQREAGS  
 Y pheasant SVKDQRSGGVIRKEVQVCRV-----PPTPYSAP EVQVLHASSCTASSGDSVELLCLVTGFSPAQIELEWLV DGMRG---LVVASNTPVVREG--  
 Y turkey SVRDP RSGGAVRKEVQVCRV-----SPTPPSAP EVQVLHGSSCAASRGGSVELLCLVTGFSPAQIELEWLV DGI RG---LLVASDSPVVREG--  
 Y quail RVTAPPSGEVLRKEVPA CLG-----SSLTPLAPEVQVLHSSSSCSPSNRETVELICLVTFGFSPPELQIDWLDIGRKAGP-TFPAIRGPMVREEGE  
 Y chicken SAAP--GGALLKKEVQVCRV-----DPVPPVAP EVQVLHASSCTPSQSEVELLCLVTGFSPASAEVEWLV DGVGG---LLVASQSPAVRSG--  
 Y/O platypus KVTHPTNTIISGNV VAPAPPTPQTTTPVVT PAMKSPPAVRVHSSCLPNGDAEATIQLLCLISDFSPAKIEVKWLEDDEEQ---DGFY--VSESKRENN  
 E platypus NVEQMATKTKINTEVYSDCS-----KDP--IPPTVKLLHSSCDPRGDSQASIELLCLITGYSPAGIQVDWLVDGQKA---ENLFPYTAPPKREGN  
 E echidna NVEQTAIKTKINTEVYSDCS-----REP--IPPTVKLFHSSCDPRGDSQATI ELLCVITGYSPAGILVDWLVDGQKA---ENLFPYTAPPKREGN  
 E opossum SVDHLPTSTKIKKTL SLPEC-----GPVTIIPPTVKLFHSSCDPRGDAHSTIQLLCLVSGFSPA KVHV TWLV DQEA---ENLFPYTTRPKREGG  
 E brushtail SVDHLPTSTKIEKHVSTGPT-----KNGPVI PPTVKLFHSSCDPRGDAHSTIQLLCLVSGFSPARVKVTWLV DQEA---ENLFPYTTRPKREGS  
 G echidna NVEHPASKTKIARKVE-----  
 G1 platypus NVEHPASKTKIDKKVE-----  
 G2 platypus SVEHPATQKNTQKTVG-----  
 G opossum NVAHPATSTKIDKKIEATTTT-----  
 G mouse NVAHPASSTKV DKKIVPRDCG-----  
 G human NVNHKPSNTKVDKKVEPKSCDK-----  
 T zebrafish TADHPSKTVNETFSTAP-----TLSLVLVPT EKNTFAMCVIEDFYTENITVRWK ENNIYK-----QSQTNLEYKLN M  
 T trout SVDHPGGAKTAVINKPVP-----KSRTVSLLSAPIGTTQYLMCMIEDFTSETVKVTWKKND-----MEVEAQTPTLGKRPS

210 220 230 240 250 260 270 280 290 300

M newt -NFDVTSWLDVTPGEWNKNSLYSCVVDHEASKFWITKNISKSLSCDDSTTAP-ATIAVFTVPPTFFQD-IFESKSAKLT CIVTNMASAENLN---ITWSRE  
 M axolotl -NFDVTSLLNIEPMDWNMDTVYSCVVDQ TASKFWNTRNMSKSM L CD-AQVGP-VKVTAF TVAPT FED-MFESKSANVTCIVTNMGTIEGFN---ITWSRE  
 M frog -VYETTSYLSITRKEWDLDTLYSCVVEHAESGSLQEK NMSKSLMCD-TPITP-TSIQVITIPPSLES-IFEKKSATLTCLVSNMANS EDLRS--ISWYKK  
 M slider ----LISRLTVS ERDWEAGRVYSCKVESK--NFSDMRNTSKSFECGLIDDCS-PEIDALLIXPNFAD-IYIRKSAILT CRVINMQST EGL---NVIWTK E  
 M turtle ----FHSHLTVTEKEWDDGGHKYS CRVEGK--NFSDSRNTSKVFECGEID-CP-QGITVQLIPPTFAD-IYIRKSATLT CRVGNMQST EGL---NVTWSKK  
 M anole -CYNMRSKLIVTKEDWLSGVKIFYCEVQNF--KYNNTLVISLYDVCPDSDGPGNGDDIRVETIAPTYAD-IYQTSSAKLT CRISNIPYGOELTEL NVTWTQE  
 M gecko --FSIISELTVTKKDWYADTEFSCQVQNE--KFNEIRNVSKVSVCEGGGECN-VRIRVETIPPSFND-IYLTKSATLT CRISNIPFGEDL-ALNVTWTRA  
 M duck -AYVTD SWLSVTEAEWDAGTVYTCQADG-----EMRNSSKSLECGLDKPDSD-SDIAVRVLPSPFVD-IFNEKVAKLTCKVSNLPTVEGL---VISWLKE  
 M pheasant -ETVAESRVGVTESEWEAGVTFSCLV D G-----EMRNTSKRMECGLEPLDP-VDITVRVIPPSFVD-IFTTKSATLT CRVSNM ANVEGL---EVSWWKE  
 M turkey -ETVAESRVEVTEGEWDSGVVIFSCLV D G-----EMRNTSKRMECGLDPIAQ-PDITVLAIPPSFVD-IFASKSARLT CRVSNMGNVESL---EVSWWKE  
 M quail -QTVTQSKVEVTESEWDSGVVIFSCLV D G-----EMRNTSKRMECGLDTPDP-AEISVRVFPSPFVD-IFLSKTAKLKRVSNM ANVDGL---EVSWWKE  
 M chicken -EVVAESRIVTESEWDTGATFSCVVEG-----EMRNTSKRMECGLEPVVQ-QDIAIRVITPSPFVD-IFISKSATLT CRVSNM ANVDGL---EVSWWKE  
 M echidna -AYQLSSSLTVSDTDWFKATDFTCVVEHP--NTHFIEMRNASYKCGGGQSGS---IKVSTTPPSFAS-IFTTKSAKLECLVTGMSTSDSL---SIVWVQY  
 M platypus -TYQLSSSLTVSDTDWFKATDFTCVVEHP--KTHFIEMRNASYKAGVPSSS---IKISTTPPSFAG-IFTTKSAKLVCSVTGMSTSDSL---SIVWTQY  
 M opossum -TYFLQSSSLTINESDWLSQSTFTCRVDHL--NAQF--QKNVSSSCAISTDSP---IEAFAIPPSFAS-IFVTKSAKLT CVVTNLPTYDSL---SISWTRK  
 M mouse QTYKVISTLTISEIDWLN LN VYTCRVDHR--GLTF--LKNVSSTCAASPST D---ILTFTIPPSFAD-IFLSKSANLTCLVSNLATYETL---NISWASQ  
 M human TTYKVTSTLTIKESDWLGQSMFTCRVDHR--GLTF--QQNASSMCVPDQDTA---IRVFAIPPSFAS-IFLTKSTKLTCLVTDLTTYDSV---TISWTRQ  
 X axolotl GLFSATSRLSVLQGEWNQGTLYSCDVTHAATNASIMANISKCAEPCSL S-----IAVSLPPPFEELYLTHSGHLTCLATNIKTTQS---FEIVWTRD

X frog GTYSSSSQLRILKGMWNKGTQYSCIVTHTSSNNTTTIANISQCTEQCHDN-----LQVYPLTPTFHD-LYFSRNAKVTCLVSSMKTIEN--FDISWERE  
A gecko DTFSTTSTANITQLEWKEGKTYTCQVIHQG--STVERNATKCRGCG-----NAVHVETIIPPSFAD-IFLTKSAKLTCRISNIPDEQDLEELNVTWIRA  
A duck KKATQWSRVNVSRQSWDQGAEFSCRVSHTSLKEPIVESISTYCTSGAP-----KLEVTLLPPSLED-LYISQNASVTCVATN--APQD--LKFSWSRS  
A pheasant GGVKQWSRVNVSRQSWDQGAEFSCRVSHTSLKEPIVESISTYCTSGAP-----KLEVTLLPPSLED-LYISQNASVTCVATN--APQD--LKFSWSRS  
A turkey EGVKQWSRVNVSRQSWDQGAEFSCRVSHTSLKEPIVESISTYCTSGAP-----KLEVTLLPPSLED-LYISQNASVTCVATN--APQD--LKFSWSRS  
A quail GCVSQWSRVNVSRQSWDQGAEFSCRVSHTSLKEPIVESISTYCTSGAP-----KLEVTLLPPSLED-LYISQNASVTCVATN--APQD--LKFSWSRS  
A chicken SGVTQWSRVNVSRQSWDQGAEFSCRVSHTSLKEPIVESISTYCTSGAP-----KLEVTLLPPSLED-LYISQNASVTCVATN--APQD--LKFSWSRS  
A echidna -----KNPG-VCPPDCPT-----VSVSLLPPSLDS-LFLDKGANLTCELTGVANVQG--ANFSWSAP  
A1 platypus -----VPQCKCSP-----KVLHPPSLEG-LFLGKGANLTCVLKGLVDPRE--TTFTWTRP  
A2 platypus -----SNGCECCSNCP-----VSVSLHPPSLES-LFLDKGANLTCELTGVSINVKG--VNFWS-P  
A opossum -----PR--PCDCPS-----GVHVSLSGSPLES-LLLIGIGANLTCGLSGLKNSNG--ATFTWVHD  
A mouse -----PPP--PITIPS-----CQPSLSLQRPALD-LLLGSASITCTLNGLRNPEG--AAFTWEPS  
A1 human -----TPPTPSPSTPPTPSPSC-CHPRLSLHRPALED-LLLGSANLTCGLTGLRDSAG--VTFTWTPS  
Y newt GTFSTTSQVNIKSDWILGERYTCVKDHPATNTSLHDSIRNCPESP---SG-VQLKVSIMPPKAKD-LYVTKQPSIVCQVTKMESADG----LSITWK  
Y axolotl GTFSTTSQVNIKSDWILGERYTCVKDHPATNTSLHDSIRNCPESP---SG-VQLKVSIMPPKAKD-LYVTKQPSIVCQVTKMESADG----LSITWK  
Y frog DTFSSRSKVSVPKEDWNSGDSYTCVKVHPASHTKTEASTKKCDD-----TA-ITPKVDVLPSPKD-LLVTKKAVYCVISRMTSTDD-----LTVQWS  
F frog -----TPKTSIMP-----  
Y turtle RTFSTHSNASVSQEDFMQDKMYTCRVSHPGTGTEEDYARKCKDVP--TTT-SSILVFTVPPSPEE-LYVGQSPKVTCLVNLPNDA--DLRVVWSRE  
Y anole YTFSTTSSANISQADWLEGTIYTCVKVHAGSQTMRARAKCEDDS-T-SQC-DGIYVYLKSPPTND-LYLNRPDKVSCVVGNGLESE--EGLKVSWSRD  
Y gecko DTFSTTSTANVTQIDWKEGKTYTCQVIHQG--HKVEKHATKCRGDSGN-CTA-NGIKVSIPLPPTAD-LYMNGEPRILICVVTGLESN--VGMKVRWSKE  
Y duck KTYMATSQTNVSRREDWKEGKTYTCQVIHQG--HKVEKHATKCRGDSGN-CTA-NGIKVSIPLPPTAD-LYMNGEPRILICVVTGLESN--VGMKVRWSKE  
Y pheasant STYSFSSRLNVSKDDWKEGKTYTCQVIHQG--HKVEKHATKCRGDSGN-CTA-NGIKVSIPLPPTAD-LYMNGEPRILICVVTGLESN--VGMKVRWSKE  
Y turkey STYSFSSRLNVSKDDWKEGKTYTCQVIHQG--HKVEKHATKCRGDSGN-CTA-NGIKVSIPLPPTAD-LYMNGEPRILICVVTGLESN--VGMKVRWSKE  
Y quail STYSVTSRVNVSKDWSGKSFYTCVKVHPGTGVSVEDHVRGCEGST---QTC-GPIQVFLPSPGD-LYIGLDAKIRCLVYNLPSKA---SLSITWSRD  
Y chicken STYSLSSRVNVSGTDWREGKSYSRVRHPATNTVVEDHVKGCPDGA---QSC-SPIQLYAIPSPGE-LYISLDAKLRCLVYNLPSDS---SLSVTWTRE  
Y/O platypus GKFSAYSSEFNITQGEWLTGKTFTCSVRHMASKKDIQDYARCKDI---NLI-QNLKVSVSPNPTD-LFIARTPSLTCLVASLP-DSEGIIK--LQWIHK  
E platypus RSFSSHSEVNITQDQWLSGKTFTCQVTHLADKKTYQDSARKCADS---DPR-G-ITVFLTPPSPTD-LYISKTPKLTCLIIDLV-STEGME--VTWSRE  
E echidna RSFSSHSEVNITQEQWLTGQFTFCQVTHLTDHKTYQDSARKCADS---DPR-G-INVFLTPPSPRD-LYLSKSPKLSCLVVDLV-NTNGLE--VTWSRE  
E opossum QTFSLQSEVNITQGWSSNTYTCVVKHNG--SIFEDSAQKCSDT---DPR-G-ISAYILPPTQD-LFVKKVPTIGCLIVDLA-SAENVK--VTWSRE  
E brushtail QTFSLQSELNITQGWTSLKTYTCQVTHNG--SIYRDNAQKCSDT---DPR-G-ISAYLSPSAFD-LYVSKAPVLTCLVVDLA-SAENVK--VSWTRE  
G echidna -----HGP-IPPCP-----SPG-G-PAVFIFPPKPKDFLSVGTGPKVTCVVVDLGFEDKDEPNVVTWYQG  
G1 platypus -----PGPSNPPHCP-----NPG-S-AAVFIFPPKPKDFLSVAGTTPKVTCLVVDLGFEDKDEPNVVTWYQG  
G2 platypus -----PRFPGSNSCP-----VLC-G-PAVFLVPPRPKDLLSEGGKPKIICVATGLRDEEKDAR--VKWYKN  
G opossum -----CPCCKCNTV-----DAG-G-PSVVFVPPNPQDVLKLSRSPKVTCLVVDLGFEDKDEPNVVTWYQG  
G mouse -----CKPC-ICTVP-----EVS---SVFIFPPKPKDVLTTITLTPKVTCLVVDLGFEDKDEPNVVTWYQG  
G human -----THTCPPCPAP-----ELL-GGSPVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVK--FNWYVD  
T zebrafish NGLHTALSLEYKLEIVIPNTEYTCVESHG-----KTFHKTQNF-----AKFRLMLKPPMVRE-MFINNRIVLQAVVSGDLSTAVK-----EAS  
T trout GLYSGSSLLKVINSDWNNKVKYSCVVEHQG--ETISKTTSKTEP-----LTVTLNPPRVRE-VFLDNQAVLECVITATDQNTVS--GTNITWH

310 320 330 340 350 360 370 380 390 400

M newt D-TKEV-LKTEMSVPIIHNNGTYSAGK--TATVCADQWAAGHKFACKVLHQ-DLAGPSTAYLQKKNGNPPKPTIVVYPPPTSEELALKE--SVTLTCLVE  
M axolotl D-TNEV-LKTEITNPIFHDNATLSVMG--IATVCADQWDAHFKFVCKVLHQ-DLAEQRVLSLQKPNGNQRRKPSVYIYPPPSSEELALKE--TATIVCLMR  
M frog SGTQEIPLKTELGDIAISDNRTYSVKG--TTTVCADWNN-DKFVCKVEHT-ELASMKEVFLFKEKG-EYNTPSVYVFPPLLEELSKRE--TATLTLVK  
M slider DG-SELKTSVGD-PKVQSNR-RFSVDA--TTSVCADEWERGDKYTCKVAHP-ERIFPLKKTTLTKEPVTNSHAPSIVYIFPPPSSEQLALRE--AATVTCLVK  
M turtle DG-KPLKTTLGD-RKVQNG-RFTVDA--TTSVCADEWERGDEYTCIVSHP-DLIFPIKNTFRKQPVTDSPRAVYVFPPLLEELALRE--AATVTCLVK

M anole PGHKILNTEYQK-PTDQNG-MQYIDA--TATVCATEWRSQTFSCVKVFPALPKPVEKKLRKTIISGIPHTPSVYVLPSPSDQLTLRE--SATLTLCLVK  
M gecko SDKKTLETTTQ-AKEQENRELVFVDA--TATICAEEWEKGDYTTCTVKHR-LLATTEVKSLLKQNGGSHSAPAVYVLPSPSEQLALQE--TATPTCLIK  
M duck DG-QKLETKTMP-RVLQNS-LYGVVEG--VASVCADEWNRKEEYVTKVSH-ELLFPVEEKLQKTEARDAKPPALYVFPSPPEQLNAHE--TATVTLAK  
M pheasant SG-AKLETAVGQ-RVLQNSG-LYTVEA--VASVCADEWDRGEDYVCKVNH-ELLFPVEERLRKMEARNAPPPKVYVFPSPPEQLNNRQ--SVSVTCMAQ  
M turkey TG-GKLETAVGQ-RVLQNSG-FYMVEA--VASVCADEWDRGEDYVCKVNH-ELLFPVEERLRKMEARNAPPPKVYVFPSPPEQLNDRQ--SFRVPCMVQ  
M quail KG-GRMETSQVQ-KVLQNSG-FYMVEA--TTSVCVDEWDGDAYVCRVNH-ELLFPVEERMKKT EARNARPPSISYPPSPDQPGQLQ--RLSITCMIQ  
M chicken KG-GKLETALGK-RVLQNSG-LYTVDG--VATVCASEWDGDDGYVCKVNH-DLLFPMEEMRKT KASNARPPSVYVFPSPPEQLNGNQ--RLSVTCMAQ  
M echidna DG-KELATKTTV-SKIOPDG-TFSAKG--EASVCAEDWQSGKRFTCTVSHA-DLPAPQSSHISKQKEVNLHSPSVYIFPPASDQLSLRE--SVTLSCLVK  
M platypus EG-KELTTKTSV-SKIOPDG-TFSATG--EASVCAEDWQSGKRFTCTVSHA-DLPAPQSAISKQKEVNLHSPAVYVLPSPASDQLSLRE--SATLSCLVK  
M opossum DG-QLLKTQKV-FSSHPNG-TFTAEG--EATVCAEENWNGEAFKCIVTHS-DHPVPLKKEIFKQEVLDHAPSVYLLRPNPEELSLRE--SATVTCMMK  
M mouse SG-EPLETKIKI-MESHNG-TFSAKG--VASVCEWNNRKEFVCTVTHR-DLPSPQKFIKPNVHKHPPAVYLLPPAREQLNLRE--SATVTLVK  
M human NG-EAVKTHNI-SESHNA-TFSAVG--EASICEDDWNNGERFTCTVHT-DLPSPKQTI SRPKGVALHRPDVYLLPPAREQLNLRE--SATITCLVT  
X axolotl TAGPL--NVVTDPPQLNDNGTYSVTS--RLAVCAEEWISGEKFTCTVKHQ-DLPSPVKVDIMKRKDG SARAPQVYLLPPSPPEELALQE--MVTFLCYIK  
X frog KAGNL--EFVTEDPVLDHNGTYSVAS--ILSVCAEDWESGDKFSCVRSQ-DLPSPVKTIFKQNEGTPKAPDVYLLPPSAQELIQQE--MVTLTCFVT  
A gecko SDNKELETVIGQPKQENSELLFVEA--TATVCKEEDWSDGTFKCKVTL-LLPTAVIKTLKLVHGGTPRAPAVYVLPSPSEQLALQE--ETATLTLCLK  
A duck EG-TA-LDVVTGEPQKQENGLYRLTS--VLKICAEENWNGESFTCGVAGP-EIQGSVTKSVQKDLAVSVQAPSVYVFPSPAEEELARQE--TATLTLCLAS  
A pheasant SG-AG-LD-VSQTEDRQADGRYTVRS--FLRVCVEEWNGGEEFEC-AVG-EEGEEVKSIRKDLDSPLHAPSVYIFPPPAEELSLQE--TATLTCMAT  
A turkey SG-AG-LTSVRRRTDRRTGVTSPGAPRSIVLRVCVEEWNGGETFEC-AVG-D-GDEVKKSIRKDLDSPLHAPSVYVFPSPAEEELSLQE--TATLTLCLAT  
A quail NNQMG-LD-VGRNEELQANGLYRVVG--TLRVCVEDWNGGESFGC-TVSY-G-EEQVKSIRKDLDSVPRPPSVYVFPSPAEEELALQE--TATLTCMAT  
A chicken SG-GG-LD-VSQTEDRQADGRYTVRS--FLRVCVEEWNGGETFEC-SVRE-EGVVAAEESIRKETDTPLHAPSVYVFPSPAEEELSLQE--TATLTCMAS  
A echidna NSVTA--KPVRRGPAVRDQGGKYTITS--TLEVCTDEWNRQGHFSCTVTH-ELREPITQTIATKSGPLIR-PAVHLLPPTTEELALNE--MATLTLCLR  
A1 platypus NDGDS--QATTGNPVEEEDGTYSLAS--VLEICAEWEHQDKFTCTVTHP-KMS-PITQTIKTPPGPLNR-PEVHLLAPSTEEELALNE--MATLTLCLR  
A2 platypus LSGTA--RPVDGPAVKDDKGYTITS--TLEVCTDEWNRGDKYCTVSH-ELPKPVTKITKVSGLFR-PEVHLLAPSTEEELALNE--LTLTLCLR  
A opossum TAQASTLRPIQGAPEQDSNGKYRVSS--VLEICTEEWLRGDTFSCVSHS-EIET-TTKTIYKPKVPQIP-PQIYLLAPSADEQALNE--MVSITCLR  
A mouse TGKD--AVQKKAQNSCGCYSVSS--VLPGCAERWNSGASFKCTVTHP-ESGT-LTGTIKAVTVNTFP-PQVHLLPPSPPEELALNE--LLSLTLCLR  
A1 human SGKS--AVQPPERDLGCYSVSS--VLPGCAEPWNGKTFCTAAYP-ESKTPLTATLSK-SGNTFR-PEVHLLPPSPPEELALNE--LVTLTLCLR  
Y newt QEDGSPLVGLPHETEVLDPDGLGADS--TLTITTDWAKQGSASFCKVEHP-DLSSPVTRTIRKPK-REIGPSMYLFPHPHQLDQH--ELVSLTLCLR  
Y axolotl RREGPEEAAVISIQYIDSDGTFAM--YLNITKNEWERGDEFTCKVKHF-DLPFPLSRSVSKPTG-RSFAPTMVYFAPHHEMELANY--DFVSLTLCLR  
Y frog RSDGKKALAFDSAPEKAYDGTFTVKS--TLKISPGDWENKQFNCKVHP-DLPSPIEKSIQKSQD-PGTEPTITLPPSDDELNRD--FISLICMLK  
F frog -----GNNTN-----TKPSIFLYSPRTKELEKDASSLISIIICLVK  
Y turtle K-TGPLSPEPLTLTEQHNR-TFTASS--SLPIFTRDWEDEKYSCKVEHS-ELPTPIIKSISKKQG-KMSPPSVYLLRPHDELSSNG-DSVSLTLCLR  
Y anole KKA-SLDPKPMVSVEELNG-TYTVVS--ALPILTREWDS EETFTCTVEYP-GVPTPIVKKITKLG-KVTTPSVYLFRRPHREELIFQSHS QLTLTLCLR  
Y gecko KPG-TLNP EPLEPAQSDG-TFTLKS--PLIISKQDWLAGIYTTCTLEHS-SGIAPYSKTI AKKTG-KRTQAQVYLFRRPHNEELKSR-DPNVSITCLVQ  
Y duck K-SGALRDPMLVTEHFNG-TFTASS--SLAISTQDWLAGERFTCTVQHE-DLPVPLGKSI AKHAG-KVTAPYIFTFPPHAEELSLA--EVTLTLCLR  
Y pheasant K-SGIFLDPDRFFQEHFNG-TYSASS--SVPISTQDWLAGESFTCTVQHE-ELPLPLTRS VYRHPG-PSPALLISFPFPPHPEELSQS--PLILGCLAR  
Y turkey K-SGALRDPMLVQEHFNG-TYSASS--AVPISTQDWLAGERFTCTVQHE-ELPLPLSRSVYRHTG-PSTAPQIFFPFPHPEELSQS--RVTLGCLVR  
Y quail KQHGHRLPDLILQEHYNG-TYSASS--SVPISTQDWLAGERFSCVQHD-ELPQPVVKG ICKETG-PSTPHIYPLPNPEELSLP--YVTLTLCLR  
Y chicken K-SGNLRDPMLVQEHFNG-TYSASS--AVPVSTQDWLSGERFTCTVQHE-ELPLPLSKSVYRNTG-PSTPHIYPLPNPEELSLP--RVTLSCVLR  
Y/O platypus -GIERPA--SPIKIMQPDGTFSAES--TLSITLPEWMEGESFTCKVQHP-DSPSIVEKAI SKPLG-KSLAPVYVFPSPHMEDELAKQD--TLSLTCLAK  
E platypus SGTPLSA--ESFEEQKQFNGTMSFIS--TVPVNIQWNEGESYTCRVAHP-DLPSPVIEKAI SKPLG-KRLAPEVYAFPPHQAELVSHGD--SVSLTLCLR  
E echidna SGTPLSS--ESFEEQKHFNGTMSFIS--TVPVNIQWNEGESYTCRVAHP-DLPAPVVRTVTKSPG-KRLAPEVYALSPPQEEVDLGG--SVSLTLCLR  
E opossum SGGPVNP--SSLVVEQYNGTFTVTS--HLPVNTDDWIEGDTYTCRLESP-DMPVPLIRTISKAPG-KRLAPEVYMLPPSPPEET--GT--TRTVTLCLR  
E brushtail SGGTVSP--SSPVVKEQYNGTFTVTS--TLPVQTDDWIEGETYTCRLEHP-DLPFPLIRTISKAPG-KRIAPEVYMFPPS EEEK--GN--TVSLTLCLR  
G echidna DKELPKSGSVEPPPKEQRNGTYRFVS--EREVSSKDWLDQKVFCKVQHK-NFPSPVIKTI SHTAG-TRKAP EAYVYSPHRDELN-KD--TFRPSCMIL  
G1 platypus DKELPKTRMLEPPPKEQRNGTYRFVS--ERDVSSKDWLDQKVFCKVQHK-NFPSPITKTI SHTAG-TRKAP EAYVYFPPHRDEMKN--SVSITCLVL  
G2 platypus GTLFPNSQNAQTSSDTIWNGT-RVSS--KLSVTPEDWKS DAEFRCEVEHK-LFPTSLKKAISHDKNTERKTEAYIFSPHTEELS-KE--SVSITCLVK

G opossum EEEVSSP--KLT-QKKLNNGTFQVVS--NLPVVHQEWLKGTSYTCKVNTS-ELPVVERKTISHTKG-ERKKPDIYVFGPHPELQKQD--DVSITCLVT  
 G mouse DVEVHTA--QTQPREEQFNSTFRSVS---ELPIMHQDWLNGKEFKCRVNSA-AFPAPIEKTISKTKG-RPKAPQVYTIPPPKEQMA-KD--KVSLTCMIT  
 G human GVEVHNA--KTKPREEQYNSTYRVVS---VLTVLHQDWLNGKEYKCKVSNK-ALPAPIEKTISKAKG-QPREPQVYTLPPSRDELTKN--QVSLTCLVK  
 T zebrafish VSCKMDNVPINSVSQENESQHVKIYN---VPVDTTKWFNGGKVTCTTRDT-LNNKDIKQEIYFNKG-DGQEPSVKMYKP--DDISTKQ---ISYVCEVS  
 T trout VNGKKQTDHIDLKPIESKGNLNSRVS---TLTIDQTKWTVNKNVQCSAMKS-GEDTPVIQDISFTKGSSEAPSVSVHILP--EEDTKKDG--DVTLVCLVV

410 420 430 440 450 460 470 480 490 500

M newt GYNPCDVFKWLVSQTDPGLEEVNTKPVEEVG---ATGSSS--CFLYSKLKVPESEWSQ-GTVYTCVVGHEALSLQVLQKSID-----  
 M axolotl GYHPCDLFVRWLENSQQLQKQDYVNTKQAEVDP---TTGQKS--CFMYSMLKIPAAQWTA-GNTYTCVVGHEALPLQITQKSID-----  
 M frog GFSPSEIFVKWLHKNEAVPKQNYINTSINDELL---PKGQKSGKFFLYSLHTIDIKWDA-GDSFSCVVGHEALPLQLTQRSID-----  
 M slider GFNPPDLFIKWLSNGEELNASEYINTKPILE-----SSQPPLYFAYSMLNINEQEWNA-GNTYTCVVGHEALPLQVTQRTVD-----  
 M turtle GYNPPDLFIKWLSNGEEVISSKYINTVSIPE-----LGQSKLYFSYSSLSISEQEWNA-GNTYTCVVGHEALPLQVTQRTVD-----  
 M anole NFNPADLFMKWLHNDQPVSSSLHYFNSEPE-----SKQSEGYFAYSMLNINEQDWSA-GDSFTCVVGHEALPLFNTTQKTID-----  
 M gecko SFYPGDFFVKWLQDGEPPVSEYFTSGPIQE-----SKSPERYFAYSILNINEQDWSA-GARLTCVVGHEALPLQMTQKTVD-----  
 M duck GFNPPDLFIRWLRNGEPLPASSYVTMPVAE-----SQLARSYFTYSALSVATEDWGA-GNVFTCLVGHERLPLQVAQKSD-----  
 M pheasant GFNPPQFFVRWLKNGQTL PQSQSVTSSPMAE-----SPENESYVAYSLLRGAEEWGA-GNVYTCVVGHEALELQLLQKSVDKASGKASAVNVSLVL  
 M turkey GFNPPQFFFFRGLRNGESLPQTHSVSPSPMVE-----SPEKEFFVAYSVLRVGGEEWGA-GNIYPWGGGQEVLEFQLVQKSVDKASGKAGAVNFSLVL  
 M quail GFNPPDYFVRWLRNGEPLPQSHWLTTTPLNQGE-----DPINESYVAYSLLKVGAEWGA-GNVYSCLVGHEALPLQLAQKSVDKASGKSSAVNVSLVL  
 M chicken GFNPPHLFVRWLRNGEPLPQSQSVTSAPMAE-----NPENESYVAYSVLRVGAEEWGA-GNVYTCVVGHEALPLQLAQKSVDRASG-----  
 M echidna AFSPADVMVQWLHKGQPVPPDKYTVSAPPE-----PQSPNLHFAYSILTVAEEEWSA-GDSFTCIVVHEALPLYVMERTVD-----  
 M platypus SFSPADVMVQWLHKGQPVPPDKYTVSAPPE-----PQSPNLHFAYSILTVAEEEWSA-GDSFTCIVVHEALPLYVMERTVD-----  
 M opossum DFSPPDVVQWMHKGQPIPEKYVTSAPPE-----PQKGGRYFYSILTVSEAQWNS-GDPFTCVVAHEALPLSSTERTVD-----  
 M mouse GFSPADISVQWLQRGQLLPQEKYVTSAPPE-----PGAPGFYFTHSILTVTEEEWNS-GETYTCVVGHEALPHLVTERTVD-----  
 M human GFSPADVVFQWMQRGQPLSPKEYVTSAPPE-----PQAPGRYFAHSILTVSEEEWNT-GETYTCVA-HEALPNRVTERTVDKSTGKPTLYNVSLVM  
 X axolotl GFNPPDTLVKWLAKGKEVDFGSYATTSPLPSLTGGSY-----YRYSSLQVPAAEWTK-GDAFTCVVGHEA-LPMNLAQKSID-----  
 X frog GFNPKEIFIQWMQGGVSISEDKFINTVPMKSDGEQTY-----FIYSKLAIPAAKWNQ-GDVFTCVVGHEA-LPLYITQOSID-----  
 A gecko GFYPPEEFFVKWLRNDEPVGDEFFTSRPVQES-----KTPERYFTSSTINVNEQDWSA-GDHYTCVVGHEAL-PLQTTQKTVD-----  
 A duck GFRPRDILVTWTQDRPVASGSFSTFGPQEGEAGLFS-----VYSKLSVAAA EWQR-GDVFCVVGHDG-IPLNFVQKSLD-----  
 A pheasant SFLPSSILLTWTQQRNPVSTQNYLNFPGPVK-DGEFFS-----IYSKLVIPVSDWQR-GDVFGCVVGHDGIPLNFIQKNIDKSAGKASHVNVSVV  
 A turkey SFFPSSILLTWTQQRNPVSTQNYLNFPGPVK-DGDFFS-----LYSKLVIPVSDWQR-GDVFGCVVGHDG-VPLNFIQKSIDKSAGKASHVNVSVV  
 A quail SFLPSSILLTWTQQRNPVSTQNYLNFPGPVQ-DGGSYS-----AYSKLVVPASDWLR-GDVYGCVVGHDG-IPLGFIQKSLDKSAGKASHVNVSVV  
 A chicken SFLPSSILLTWTQQRNPVSTQNYLIFGPEK-DGDFYS-----LYSKLVKSVEDWQR-GDVYGCVVGHDG-IPLNFIHKRID-----  
 A echidna GFSPRELLVKWMKGGQEVPRTDYVTGTPQQEISEGSP-----TFFLYSTLRVQTSSWKS-GENFSCVVGHEA-LPLNFTQKTID-----  
 A1 platypus GFNPPDLLVKWLKGGQEVSTDYVTSSPQREASEGSAS-----TFFLYSTLRVPTSEWKE-GENYSCVVGHEA-LPLNFTQKTID-----  
 A2 platypus GFSPKELMVKWLKGGQEVPRKDYVTGSPQREVSEGSAS-----TFFLYSTLRVQTSTWKE-GENFSCVVGHEA-LPLNFTQKTID-----  
 A opossum GFSPEDVFIRWLKGS EELPKKDYITSNPYPEP-KSTS-----TYMVSSILQVQSTDWKN-ENKYSCVVGHEA-LPLNFTQQTID-----  
 A mouse AFNPKEVLRVWLHGNEELSPESYLVEPLKEPEGEGAT-----TYLVTSVLRVSAETWKQ-GDQYSCMVGHEA-LPMNFTQKTID-----  
 A1 human GFSPKDVLRVWLQGSQELPREKYLTVASRQEPSQGT-----TFAVTSILRVAAEDWKK-GDTFSCMVGHEA-LPLAFTQKTID-----  
 Y newt GFSPDDIYVQWKHRNTVLPDNSRNTALVLESQTN-----GPDTYFMSLLTISAKSNWEN-RDTYSCIAFHSAHPKNQMORSI-----  
 Y axolotl SFSPDDIYIQWKQKSVIPSDKYVSMERQEAETA-----GLGTYFYSMLTIQKSDWDK-RETFTCVAAHSVAPKNLMTRRI-----  
 Y frog NFRPQDIYVFWKKDGVTL EEDYYMTTTPVLEEE-----EEGFISFSLKTIARS DWMR-GATYSCIAAHTISQ-----  
 F frog GFYPKNVNVTVQONGSPMNASQVLSNEPQLNNGS-----GDNTYAMFSMITISKD-----  
 Y turtle GYYPAEISVKWMEHESQTSMPKPVTTSSMKE-----GDGDSTYFLYSKLPVDKTSWNN-GVYTCMVIHEALKPLKFTQRNI-----  
 Y anole NLNPKDVSQWLKDNNALEDNHITT-PVLKD-----SIEDSYFVYSKLLISRADWDR-GSSYTCMVIHEGL-AMKFTQRTVE-----  
 Y gecko GFNPEDISIKWLEHNNAVAGNNHVTT-QVQMD-----SDQDSFFVYSKLTVPKANWWD-GHSFTCHVVHEGF-SMKYTQRTIE-----



Y duck	GFQPEHVEVQWLRNHNNSVPAAEFVTTPLKE-----PNGDG-TFFLYSKMTVPKASWQG-GVSYACMVVHEGL-PMRFTQR-----
Y pheasant	GFPPRDMEIRGFRDPRNVPTTFKVFVTTSLFPEKRSNGNANPGREGETYFVYSKMSVEPSGWRG-ATVYPCMVVQREAL-PMRFTIQPPWQKQLGK-----
Y turkey	GFRPRDIEIRWLRDHRNVPTTDFVPISTFFPEERSRNGGPGREGETYFVYSKMSVEATSWRG-GTVFPCMVVQREAL-PMRFTQRTGQKQAGK-----
Y quail	GFRPRDIEIRWLRDHRVAVPSTSYVTTSVLPEVTSNGGGNGSDGKTYFVYSQMRVEVGEWRR-GTSYACMAVHEAL-PMRFSQRTLQKMPGK-----
Y chicken	GFRPRDIEIRWLRDHRVAVPATEFVTTAVLPEERTANG-AGGDGDTFFVYSKMSVETAKWNG-GTVFACMAVHEAL-PMRFSQRTL-----
Y/O platypus	SFFPADIAVQWLHNDEDVEEDHFSVTKPQKDL-----TGQGTFFLYSKLDIQKSNWKR-GDSFTC-----
E platypus	GFYPENISVRWLLDNKPLPTEHYRRTTKPLKDQ-----GDPAYFLYSRLAVNKSTWEQ-GNVYTCQVVHEALP-SRNTERKFQHTSGN-----
E echidna	GFYPRDVSVLWLLNNEELPTERYQTSKPLKDQ-----GDPAYFLYSRLAVNRSDEWV-STSYTCQVVHEALP-SRKTERTKQHPSTGN-----
E opossum	GFYPSSEISVQWLFNNEEDHTGHHTTTRPQKDH-----GTDPSFFLYSRMLVNKSIWEK-GNLVTCRVVHEALPGSRTLEKSLHYSAGN-----
E brushtail	AFYPADITVQWLRDNKDDHTGHHTTTRPHKDH-----GDPDSFFLYSRMVNRSHWQE-GHTFTCRVVHEALPGTRTLDKSLHYSTGN-----
G echidna	DFYPESTITVEWLQDDKVPVEADYASTLPQMH-----GSTFFMYSKLDVQKADWQR-GRAYSCSVKHEALPQKFLQKTV-----
G1 platypus	DFYPDIAIAIDWQHNDRVPVEGDYATTLQKN-----GNSYFLYSKLTVQKTEWVQ-GGSFTCSVRHEALPQKFLQKTV-----
G2 platypus	GFLPQDISIAWQHKGKEMKEEYSTTPPQYR-----NGSYFLYSKLTVTKKDWT-GESFSCLVYHDS-----
G opossum	NFFPEDVVIEWQKNNNPESEDKYYTTPPTRE-----KSTYFFYSKLIIVKKRDWVQ-NNSYTCVVLHEAFPNQISQRTI-----
G mouse	DFYPEDITVEWQWNGQPA-ENYKNTQPIMNT-----NGSYFVYSKLVNQQSNWEA-GNTFTCSVLHEGLHNHHTKSL-----
G human	GFYPSDIAVEWESNGQPE-NNYKTTTPVLDL-----DGSFFLYSKLTVDKSRWQQ-GNVFSCSVMHEALHNHYTQKSL-----
T zebrafish	SPNLGDVYIMWKVNNFTTEGKSSDPIQQQGSTS-----VVSILTISKKEFENPETTINCAVVHANMKDTASPLLKST-----
T trout	SPSLCDVYIMWKEDSGEYQEGVTSPPQKTKKG-----NYFVTSVFTTTTKDKWDT-NVLFTCAVKHAGSDNSTS-----

	.... ....
M newt	-----
M axolotl	-----
M frog	-----
M slider	-----
M turtle	-----
M anole	-----
M gecko	-----
M duck	-----
M pheasant	ADSAAACYN
M turkey	ADSVAPCF-
M quail	ADSASACY-
M chicken	-----
M echidna	-----
M platypus	-----
M opossum	-----
M mouse	-----
M human	SDTAGTCY-
X axolotl	-----
X frog	-----
A gecko	-----
A duck	-----
A pheasant	LSDDVTCY
A turkey	LSDDVTCY
A quail	LADSEVSCY
A chicken	-----

**Supplemental Figure 3. Amino acid alignment of constant regions of vertebrate immunoglobulins used in Figure 6 phylogeny.** Sequences (database accession numbers in Supplemental Table 3) were aligned using Clustal in MEGA then manually adjusted based on cysteine residues in paralogous domains. That alignment was used for the dendrogram and exported to Bioedit for creation of this figure.

A echidna	-----
A1 platypus	-----
A2 platypus	-----
A opossum	-----
A mouse	-----
A1 human	-----
Y newt	-----
Y axolotl	-----
Y frog	-----
F frog	-----
Y turtle	-----
Y anole	-----
Y gecko	-----
Y duck	-----
Y pheasant	-----
Y turkey	-----
Y quail	-----
Y chicken	-----
Y/O platypus	-----
E platypus	-----
E echidna	-----
E opossum	-----
E brushtail	-----
G echidna	-----
G1 platypus	-----
G2 platypus	-----
G opossum	-----
G mouse	-----
G human	-----
T zebrafish	-----
T trout	-----



**Supplemental Figure 4. Genomic synteny of IgX is consistent with its giving rise to IgA.** Genomic assemblies and published genomic studies of the IgH locus were used to compare the position of the constant genes of IgX of amphibians with IgA of birds and mammals. The asterisk denotes that IgA is present in some reptiles such as the leopard gecko though genomic data is lacking.