

Supplemental Table 1 Pax sequences

Phylum	Animal species	Gene name	Genome sequence	cDNA or aa sequence
Dicyemida	<i>Dicyema acuticephalum</i>	Pax6	AB266034	AB266035
Annelida	<i>Platynereis dumerilii</i>	Pax6		CAJ40659
Arthropoda	<i>Drosophila melanogaster</i>	toy		NP_524638
Arthropoda	<i>Drosophila melanogaster</i>	ey *		O18381
Arthropoda	<i>Drosophila melanogaster</i>	Pox-neuro		P23758
Arthropoda	<i>Tribolium castaneum</i>	Pax6 like		XP_975543
Cephalochordata	<i>Branchiostoma floridae</i>	Pax6		CAA11366
Cnidaria	<i>Tripedalia cystophora</i>	PaxB		AAQ17211
Cnidaria	<i>Acropora millepora</i>	PaxB		AAF64460
Cnidaria	<i>Nematostella vectensis</i>	PaxA		AAW29066
Cnidaria	<i>Nematostella vectensis</i>	PaxB		AAW29067
Cnidaria	<i>Nematostella vectensis</i>	PaxC		AAW29068
Cnidaria	<i>Nematostella vectensis</i>	PaxD		AAW29069
Hemichordata	<i>Saccoglossus kowalevskii</i>	pax6		AAP79294
Mollusca	<i>Loligo opalescens</i>	Pax-6		AAB40616
Mollusca	<i>Eupryma scolopes</i>	Pax6		AAM74161
Nematoda	<i>Caenorhabditis elegans</i>	vab-3		NP_001024572
Nemertea	<i>Lineus sanguineus</i>	Pax6-like		CAA64847
Placozoa	<i>Trichoplax adhaerens</i>	PaxB		AAV68376
Platyhelminthes	<i>Dugesia japonica</i>	Dj-Pax6(A)		BAA75672
Platyhelminthes	<i>Dugesia japonica</i>	Dj-Pax6B *		CAC85262
Porifera	<i>Ephydatia fluviatilis</i>	Pax-2/5/8		BAA36346
Urochordata	<i>Ciona intestinalis</i>	Pax6		NP_001027641
Urochordata	<i>Phallusia mammilata</i>	Pax-6		CAA71094
Vertebrata	<i>Xenopus laevis</i>	MGC52531		AAH41712
Vertebrata	<i>Homo sapiens</i>	PAX1		NP_006183
Vertebrata	<i>Homo sapiens</i>	PAX2		NP_003978
Vertebrata	<i>Homo sapiens</i>	PAX6		NP_000271
Vertebrata	<i>Homo sapiens</i>	PAX7		NP_002575

*, sequences not used in the aa substitution rate analysis.

Supplemental Table 2 Zic sequences

Phylum	Animal species	Gene name	Genome sequence	cDNA or aa sequence
Dicyemida	<i>Dicyema acuticephalum</i>	ZicA	AB266036	AB266039
Dicyemida	<i>Dicyema acuticephalum</i>	ZicB	AB266037	AB266038
Annelida	<i>Tubifex tubifex</i>	Tt-Zic	AB231869	AB231870
Arthropoda	<i>Drosophila melanogaster</i>	Opa		NP_524228
Arthropoda	<i>Anopheles gambiae</i>	ENSANG00000009802		XM_321856
Arthropoda	<i>Pandinus imperator</i>	Pi-Zic	AB231876	AB231877
Arthropoda	<i>Artemia franciscana</i>	Af-Zic	AB231878	AB231879
Cephalochordata	<i>Branchiostoma floridae</i>	AmphiZic	AB231866	BAE94124
Cnidaria	<i>Scolionema suvaense</i>	Ssu-Zic	AB231882	AB231883
Cnidaria	<i>Hydra vulgaris</i>	HyZic		AAR10817
Cnidaria	<i>Nematostella vectensis</i>	Nv-ZicA	AB231867	
Cnidaria	<i>Nematostella vectensis</i>	Nv-ZicE	AB231868	
Echinodermata	<i>Strongylocentrotus purpuratus</i>	Sp-Zic	[ref. in 14]	
Echinodermata	<i>Asterina pectinifera</i>	Ap-Zic	AB231871	AB231872
Mollusca	<i>Loligo bleekeri</i>	Lb-Zic		AB231874
Mollusca	<i>Octopus ocellatus</i>	Oo-Zic		AB231875
Mollusca	<i>Corbicula</i> sp.	Cj-Zic	AB231873	
Mollusca	<i>Spisula solidissima</i>	Sso-Zic	AB231865	
Nematoda	<i>Caenorhabditis elegans</i>	Ref-2		AAM55473
Platyhelminthes	<i>Dugesia japonica</i>	Dj-ZicA		AB231880
Platyhelminthes	<i>Dugesia japonica</i>	Dj-ZicB		AB231881
Platyhelminthes	<i>Schistosoma mansoni</i>	Sma-Zic	AB231864	
Urochordata	<i>Ciona intestinalis</i>	ZicL		NP_001027958
Urochordata	<i>Ciona intestinalis</i>	macho1		BAE06762
Urochordata	<i>Halocynthia roretzi</i>	ZicN		BAC23063,
Urochordata	<i>Halocynthia roretzi</i>	macho1		BAB19958
Vertebrata	<i>Xenopus laevis</i> .	Zic2		AB009565
Vertebrata	<i>Xenopus laevis</i> .	Zic5		AB034983
Vertebrata	<i>Mus musculus</i>	Zic2 *		NP_033600
Vertebrata	<i>Mus musculus</i>	Zic5 *		NP_075363
Vertebrata	<i>Homo sapiens</i>	ZIC2		NP_009060

Vertebrata	<i>Homo sapiens</i>	ZIC5	NP_149123
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*, sequences not used in the aa substitution rate analysis.

Supplemental Table 3 Actin sequences

Phylum	Animal species	Gene name	Genome sequence	cDNA or aa sequence
Dicyemida	<i>Dicyema acuticephalum</i>	actin1	AB266028	AB266029
Dicyemida	<i>Dicyema acuticephalum</i>	actin2	AB267841	AB267840
Annelida	<i>Helobdella triserialis</i>	actin		CAA04046
Annelida	<i>Lumbricus terrestris</i>	Actin		CAA65362
Arthropoda	<i>Aedes aegypti</i>	actin		AAA62350
Arthropoda	<i>Artemia franciscana</i>	actin		ABG27014
Arthropoda	<i>Apriona germari</i>	actin		AAV65298
Arthropoda	<i>Apis mellifera</i>	actin		XP_623826
Arthropoda	<i>Daphnia magna</i>	actin		CAB99474
Arthropoda	<i>Drosophila melanogaster</i>	actin		BAA20058
Arthropoda	<i>Helicoverpa armigera</i>	actA3a		CAA66218
Arthropoda	<i>Homarus gammarus</i>	beta actin		CAE46725
Arthropoda	<i>Haemaphysalis longicornis</i>	actin		AAP81255
Arthropoda	<i>Ixodes ricinus</i>	actin		CAI63975
Arthropoda	<i>Lymantria dispar</i>	actin		AAD54427
Arthropoda	<i>Limulus polyphemus</i>	actin		CAA86289
Arthropoda	<i>Ornithodoros moubata</i>	actin		BAE46505
Arthropoda	<i>Rhipicephalus appendiculatus</i>	actin		AAP81256
Arthropoda	<i>Toxoptera citricida</i>	putative actin		AAU84923
Cephalochordata	<i>Branchiostoma belcheri</i>	Actin cytoplasmic		BAA13444
Cephalochordata	<i>Branchiostoma floridae</i>	Actin cytoplasmic		BAA13350
Echinodermata	<i>Strongylocentrotus purpuratus</i>	actin		NP_999634
Echinodermata	<i>Tripneustes gratilla</i>	CyI actin		AAB31965
Hemichordata	<i>Saccoglossus kowalevskii</i>	actin		CAA74016
Mollusca	<i>Biomphalaria tenagophila</i>	actin		AAK68714
Mollusca	<i>Chlamys farreri</i>	actin		AAP88387
Mollusca	<i>Crassostrea gigas</i>	Actin 2		BAB84579
Mollusca	<i>Dreissena polymorpha</i>	cytoplasmic actin		AAC32224
Mollusca	<i>Haliotis iris</i>	actin A1		AAX19286
Mollusca	<i>Helisoma trivolvis</i>	actin		AAK68715
Mollusca	<i>Loligo pealei</i>	beta actin		AAU11523

Nematoda	<i>Caenorhabditis elegans</i>	actin		CAA34718
Nematoda	<i>Cooperia oncophora</i>	actin		AAR21857
Nematoda	<i>Globodera rostochiensis</i>	actin		AAN15196
Nematoda	<i>Onchocerca volvulus</i>	Actin-1A		A48449
Nematoda	<i>Plectus acuminatus</i>	actin		CAA10111
Nematoda	<i>Panagrellus redivivus</i>	actin		AAQ89578
Nematoda	<i>Setaria digitata</i>	actin		AAD13153
Nematoda	<i>Wuchereria bancrofti</i>	actin		AAF25819
Platyhelminthes	<i>Diphyllbothrium dendriticum</i>	Actin-1/4		P68556
Platyhelminthes	<i>Diphyllbothrium dendriticum</i>	Actin-2 *		P53456
Platyhelminthes	<i>Diphyllbothrium dendriticum</i>	Actin-3 *		P53457
Platyhelminthes	<i>Diphyllbothrium dendriticum</i>	Actin-5 *		P53458
Platyhelminthes	<i>Diphyllbothrium dendriticum</i>	Actin-6 *		P53459
Platyhelminthes	<i>Echinococcus granulosus</i>	actin 1		AAC37175
Platyhelminthes	<i>Echinococcus granulosus</i>	actin 2 *		AAC80574
Platyhelminthes	<i>Girardia tigrina</i>	actin		AAD11530
Platyhelminthes	<i>Schistosoma japonicum</i>	actin		AAW27501
Platyhelminthes	<i>Schistosoma mansoni</i>	Actin-1		P53470
Urochordata	<i>Ciona Savignyi</i>	CsCa1		BAA25398
Urochordata	<i>Halocynthia roretzi</i>	HrCA1		BAA08112
Urochordata	<i>Molgula occulta</i>	cytoskeletal actin 1		AAC28357
Urochordata	<i>Oikopleura longicauda</i>	cytoplasmic actin		BAA86216
Vertebrata	<i>Acanthopagrus schlegelii</i>	beta actin		AAR84618
Vertebrata	<i>Danio rerio</i>	Actin		NP_001032193
Vertebrata	<i>Epinephelus coioides</i>	beta actin		AAR97600
Vertebrata	<i>Physalaemus pustulosus</i>	beta actin		AAO67718
Vertebrata	<i>Rivulus marmoratus</i>	beta actin 2		AAV97945
Vertebrata	<i>Lethenteron japonicum</i>	cytoplasmic actin		BAB41207
Vertebrata	<i>Monopterus albus</i>	beta-actin		AAT69683
Vertebrata	<i>Oryctolagus cuniculus</i>	gamma non-muscle actin		CAA43140
Vertebrata	<i>Oncorhynchus mykiss</i>	beta-actin		AAF80342
Vertebrata	<i>Pagrus major</i>	beta cytoplasmic actin		BAD88412
Vertebrata	<i>Sigmodon hispidus</i>	beta actin		AAL16942
Vertebrata	<i>Triakis scyllium</i>	beta actin		BAB91355

*, sequences not used in the aa substitution rate analysis.

Supplemental Table 4 ATP synthase beta subunit sequences

Phylum	Animal species	Gene name	Genome sequence	cDNA or aa sequence
Dicyemida	<i>Dicyema acuticephalum</i>	ATP synthase beta subunit	AB266032	AB266033
Arthropoda	<i>Anopheles gambiae</i>	ENSANGP00000016863		XP_320445
Arthropoda	<i>Drosophila melanogaster</i>	ATP synthase beta subunit		CAA50332
Arthropoda	<i>Tribolium castaneum</i>	similar to CG11154-PA, isoform A		XP_972481
Cnidaria	<i>Metridium senile</i>	ATP synthase beta subunit		AAT06144
Cnidaria	<i>Obelia</i> sp.	ATP synthase beta subunit		AAT06143
Echinodermata	<i>Asterina miniata</i>	ATP synthase beta subunit		AAT06134
Echinodermata	<i>Strongylocentrotus purpuratus</i>	similar to CG11154-PA, isoform A		XP_783293
Mollusca	<i>Haliotis rufescens</i>	ATP synthase beta subunit		AAZ30686
Mollusca	<i>Pinctada fucata</i>	ATP synthase beta subunit		ABC86835
Nematoda	<i>Caenorhabditis elegans</i>	Atp synthase subunit protein 2		AAA19068
Nemertea	<i>Lineus viridis</i>	ATP synthase beta subunit		AAZ30652
Platyhelminthes	<i>Stylochus</i> sp.	ATP synthase beta subunit		AAT06145
Porifera	<i>Ephydatia cooperensis</i>	ATP synthase beta subunit		AAT06136
Porifera	<i>Microciona prolifera</i>	ATP synthase beta subunit		AAZ30673
Vertebrata	<i>Homo sapiens</i>	F1 beta subunit		BAA00016
Vertebrata	<i>Mus musculus</i>	ATP synthase, H ⁺ transporting mitochondrial F1 complex, beta subunit		BAE30095
Vertebrata	<i>Tetraodon nigroviridis</i>	unnamed protein product		CAG04958

Supplemental Table 5 Aldolase sequences

Phylum	Animal species	Gene name	Genome sequence	cDNA or aa sequence
Dicyemida	<i>Dicyema acuticephalum</i>	fructose-bisphosphate aldolase	AB266030	AB266031
Arthropoda	<i>Tribolium castaneum</i>	similar to CG6058-PF, isoform F isoform 3		XP_975842
Arthropoda	<i>Anopheles gambiae</i>	ENSANGP00000012760		EAA08079
Arthropoda	<i>Drosophila melanogaster</i>	fructose-bisphosphate aldolase (EC 4.1.2.13) 4 alpha		JX0233
Cephalochordata	<i>Branchiostoma belcheri</i>	aldolase		BAA21101
Echinodermata	<i>Strongylocentrotus purpuratus</i>	similar to aldolase a, fructose-bisphosphate		XP_790001
Mollusca	<i>Biomphalaria glabrata</i>	fructose-biphosphate aldolase		AAZ39527
Nematoda	<i>Caenorhabditis elegans</i>	Fructose-bisphosphate aldolase 1		P54216
Platyhelminthes	<i>Schistosoma japonicum</i>	SJCHGC00411		AAW25258
Platyhelminthes	<i>Schistosoma mansoni</i>	fructose bisphosphate aldolase		AAB84014
Platyhelminthes	<i>Echinococcus multilocularis</i>	fructose-bisphosphate-aldolase		CAC18550
Vertebrata	<i>Danio rerio</i>	Aldolase a, fructose-bisphosphate, a		AAH44379
Vertebrata	<i>Homo sapiens</i>	ALDOA		CAG46678
Vertebrata	<i>Mus musculus</i>	Aldolase 1, A isoform		AAH43026