TECHNICAL WHITE PAPER:
TOP 1,000 GENES ANALYSIS: VALIDATION OF FREQUENTLY ACCESSED GENES IN THE ALLEN MOUSE BRAIN ATLAS

This white paper is an update to the November 2007 white paper that compared *in situ* hybridization data for the most frequently accessed 1,000 genes in the ALLEN **Mouse Brain Atlas** to other data public data sources. This white paper examines a new top 1,000 genes list that reflects more recent usage.

INTRODUCTION

As a validation of the *in-situ* hybridization data in the Allen Mouse Brain Atlas (the Atlas), an analysis of the 1,000 genes receiving the greatest number of website hits was performed. The highest-ranked 100 of these 1,000 genes were investigated by comparison with peer reviewed literature from scientific journals. The expression patterns of the remaining 900 genes were compared whenever possible to those in two online mouse brain gene expression databases: Brain Gene Expression Map (BGEM) and Gene Expression Nervous System Atlas (GENSAT). Comparison with peer reviewed literature was made for the remaining 900 genes in cases where neither online database was available for comparison. In addition to gene expression validation, the top 1,000 genes were categorized according to standard gene ontology. The data from the gene expression and ontological analyses are presented below.

METHODS

Generation of Top 1,000 Gene List

All 20,000+ genes in the Atlas were ranked according to the number of combined hits received on the website www.brain-map.org. Web hits for a gene are a measure of interest in that gene among all the Atlas users. The 1,000 genes with the greatest number of hits for the period between October 2005 and March 2010 were selected for this analysis.

Literature Comparison of Top 100 Genes

The 100 highest-ranked genes were chosen for scientific literature comparison. Articles found by querying the Pubmed and MGI databases were selected for data comparable to the Atlas data. Using only articles containing images of mRNA or protein data from adult rat or mouse, expression profiles were compared. Whenever possible, a whole brain comparison was performed. Expression in each coronal or sagittal section in the literature was compared structure by structure with expression in matching sections in the Atlas. If a whole-brain data set was not provided in the literature, hallmark expression within individual structures was compared using textual descriptions of expression as an additional means of comparison. In cases in which no pertinent articles could be found, BGEM and GENSAT were consulted for comparison. If neither literature, nor BGEM/GENSAT validation were forthcoming, and the probe used for adult *in situ* hybridization in the Atlas was identical to the probe used in the ALLEN **Developing Mouse Brain Atlas**, a comparison of the developmental expression pattern to available literature was performed, as a means of validating the probe used in the adult Atlas.

Database Comparison of Next 900 Genes

The next 900 highest-ranked genes were compared to gene expression data in two publicly available on-line databases, BGEM and GENSAT. The BGEM database presents darkfield images of mRNA expression across the mouse brain using radioactive riboprobes for *in situ* hybridization. GENSAT contains gene

expression data generated from bacterial artificial chromosome (BAC) transgenic mice, where endogenous protein coding sequences have been replaced with sequences encoding an EGFP reporter gene in each transgenic vector. Because each of these databases uses a different experimental methodology, unique criteria were required for comparisons between their data and that of the Atlas. Peer reviewed literature was consulted whenever no comparable data were found in either BGEM or GENSAT. If validation was not possible using BGEM, GENSAT, or adult literature comparisons, and the probe used for adult *in situ* hybridization was identical to the probe used in the Allen Developing Mouse Brain Atlas, a comparison of the developmental expression pattern to available literature was performed.

BGEM
Because its platform is more similar to the colorimetric in situ hybridization platform of the Atlas, the BGEM database was the preferred data source for comparisons. Whenever possible, coronal and sagittal sections (maximum of 8 and 3 respectively) of adult data were compared to corresponding Atlas coronal and sagittal sections, and corresponding structures were compared. If data in only one plane was provided, it was considered sufficient as a means of comparison. As the BGEM database was the primary data source for the majority of comparisons, a putatively equivalent expression pattern to the Atlas data was considered sufficient for validation. However, if a gene was not found in the BGEM database, or if BGEM data were not of sufficient quality to carry out the comparison, GENSAT was used as an alternative data source.

GENSAT
The GENSAT database supplies gene expression data derived from transgenic mice in the sagittal plane (~13 sections). Because of the greater difference between GENSAT and the Atlas platforms, more general comparison criteria were required for a positive validation from GENSAT than BGEM. For these comparisons, hallmark features of expression (i.e. cortex laminarity, expression restricted to individual nuclei, expression restricted to a particular cell type, etc.) were examined in both data sets and compared. If these hallmark features of expression matched across the brain, the match was considered sufficient for validation. However, if a gene was not found in GENSAT, then peer reviewed literature was consulted.

Literature
For the remaining 900 genes, peer reviewed literature was referred to in cases where a validation from BGEM or GENSAT data was not achieved. Literature was also consulted when BGEM or GENSAT data disagreed with the Atlas data. The literature comparisons for these genes were equivalent to those carried out for the top 100 genes. A literature match was considered a validation of the Atlas data, in spite of mismatching BGEM and/or GENSAT data. In cases where BGEM, GENSAT, and adult literature failed to produce a validation, and our adult Atlas probe was used in the Allen Developing Mouse Brain Atlas, a literature comparison to developmental data was performed. The Atlas data were considered validated if the developmental atlas comparison was positive.

Probe Validation Using Developmental Mouse Brain Atlas Data
For cases in which a gene could not be validated by comparison to adult mouse or rat literature, BGEM, or GENSAT, AND the gene had corresponding data in the Allen Developing Mouse Brain Atlas, a comparison between the expression pattern of the developmental data and analogous literature was made. The requirements for a positive validation were that the probe used in the developmental atlas was identical to the probe used in the adult atlas, and that the literature used for validation was mouse data of a comparable age to that of the Allen Developing Mouse Atlas data. For developmental literature comparison, the same criteria were used as for adult literature comparison: whole brain comparison was preferred, but structure to structure comparison was also acceptable. Validation by developmental literature was considered sufficient to discount a mismatch with adult BGEM or GENSAT data.

Analysis of Gene Ontology
The top 1,000 genes were additionally subjected to a gene ontology analysis using PANTHER (Protein Analysis Through Evolutionary Relationships). PANTHER is a classification system that uses evolutionary relationships combined with published experimental evidence to classify genes by function. Thus, by providing a categorical analysis of the top 1,000 genes in the Atlas, PANTHER offers a measure of the interest in each gene family for the scientific community using the Atlas. The top 10 molecular function categories for the 1,000 genes are presented in Figure 1. A sub-family analysis was carried out on the top

three of these categories: transcription factors, ion channels, and G protein-coupled receptors (Figures 2, 3, and 4). The GPCR sub-family analysis was carried out using the KEGG BRITE Database.

RESULTS

Top 100 Genes

A comparison between peer reviewed literature and the Atlas data for the top 100 genes yielded the following results: 95 of 100 genes were validated by comparison with peer reviewed literature, the expression pattern of one gene was found to disagree with the literature, and 4 genes were not found in literature (all four were subsequently validated by either BGEM, or developmental mouse data literature comparison). The single mismatch in the top 100 was found to be insufficient due to a quality issue, and the experiment will be repeated.

Next 900 Genes

Of the remaining 900 genes, 659 (73%) were validated by BGEM, GENSAT, or comparison with peer reviewed literature. Comparable data from external sources were not found in 212 of 900 genes (23%). The expression patterns of 29 of 900 (3%) genes were found to disagree with comparable data from external sources. All mismatches will be examined on an individual basis in order to determine how best to improve agreement with external data. A summary of comparisons is provided in Table 1.

Table 1: Summary of top 1,000 genes analysis

Top 100 genes	
Validated	**99**
Mismatches	**1**
Unvalidated	**0**
Next 900 genes	
Validated	**659**
Mismatches	**29**
Unvalidated	**212**

Mismatches

For the top 100 genes, peer reviewed literature was the initial source for comparison. If the peer reviewed literature did not support the Atlas data, it was considered a mismatch. For the remaining 900 genes, BGEM was the initial source for comparison. If BGEM data were not found or did not match the Atlas data, GENSAT was consulted. If GENSAT data were not found or did not match the Atlas data, then peer reviewed literature sources were consulted (including developmental mouse data comparison if necessary). A mismatch occurred when BGEM or GENSAT data did not agree with the Atlas data, and no literature source could be found to support the Atlas expression pattern. For 5 genes, existing quality issues prohibited comparison with any external sources.

BGEM discrepancies

In total, there were 11 genes that disagreed with BGEM data that went on to become mismatches after subsequent comparison with GENSAT and literature. One source of discrepancies between the Atlas and BGEM data in general is the difference in experimental methodologies. BGEM uses radioactive probes for in situ hybridization and presents data as darkfield images. The Atlas uses colorimetric probes and presents data as brightfield images. These experimental differences made the data sets difficult to compare, particularly when expression was at very low levels. In addition, the difference in sampling frequencies made comparisons between smaller structures a challenge.

GENSAT discrepancies

In total, there were 5 genes that were in disagreement with GENSAT data that went on to become mismatches. One of these could not be found in literature, and became a mismatch based solely on its disagreement with GENSAT, while the 4 others were also found to disagree with literature sources. As with

BGEM, differences in platform are likely to account for many of the discrepancies between the Atlas and GENSAT data. Because the methodology used by GENSAT does not directly measure mRNA abundance, fine-scale comparisons of GENSAT and the Atlas in situ hybridization data were particularly difficult. Differences in sampling frequency and the absence of coronal GENSAT data further complicated comparisons between data sets.

Literature mismatches

In total, 9 genes were found to be in disagreement with peer reviewed literature sources only. Each of these genes was immediately considered a mismatch. Again, depending on the platform used in each case, differences in experimental methodology were an obstacle to comparison. However, because these data were found in peer reviewed literature and because they were selected for comparability, disagreements between literature and the Atlas data were considered particularly reliable. In each of these cases, the Atlas probes are under investigation and experiments will be repeated in order to improve data accuracy. A detailed list of all genes with comparison data is provided in Table 2.

Gene Ontology

The top 1,000 genes were analyzed by PANTHER and categorized by molecular function. The top 10 molecular function categories are presented in Figure 1. According to this analysis, three categories in particular contained a substantially greater number of genes than other categories: transcription factors, ion channels, and G-protein coupled receptors (97, 93 and 89 genes, respectively). These top three categories were subsequently selected for additional analysis by molecular function sub-family. The results of the sub-family analysis are presented in Figures 2, 3, and 4.

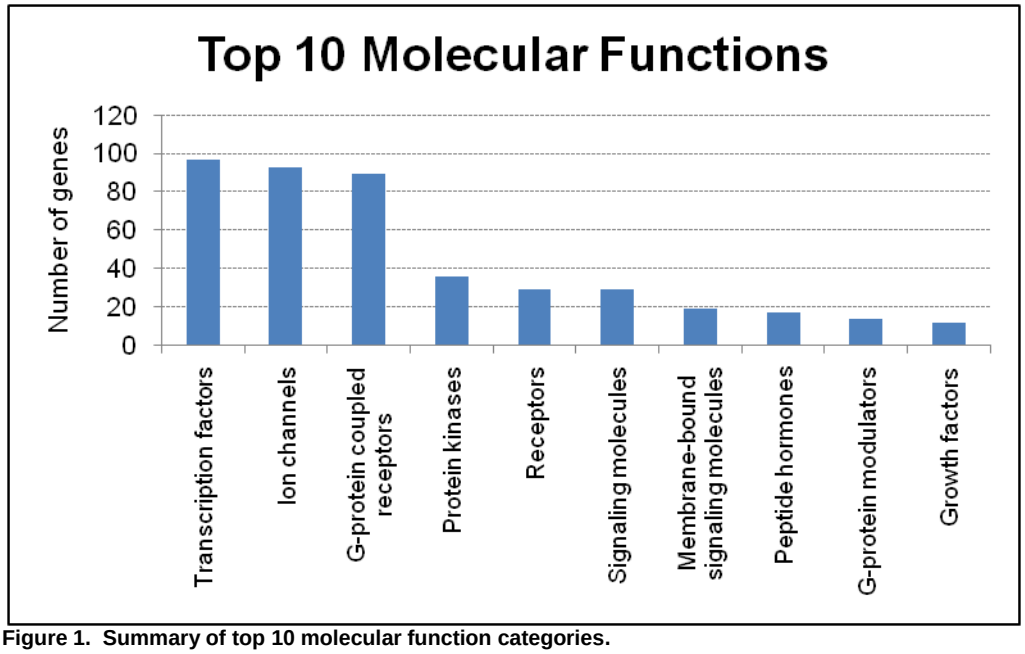

Figure 1. Summary of top 10 molecular function categories.

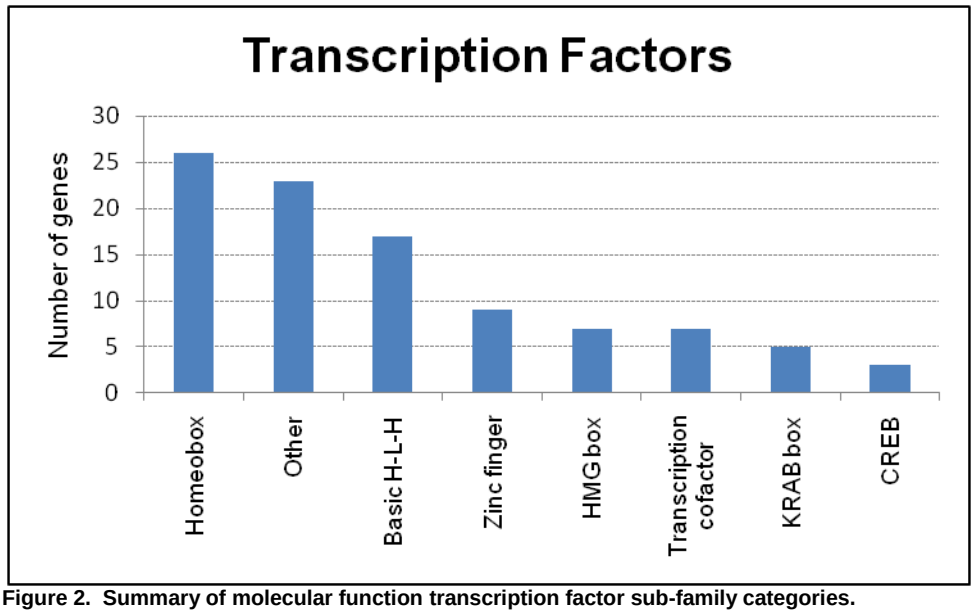

Figure 2. Summary of molecular function transcription factor sub-family categories.

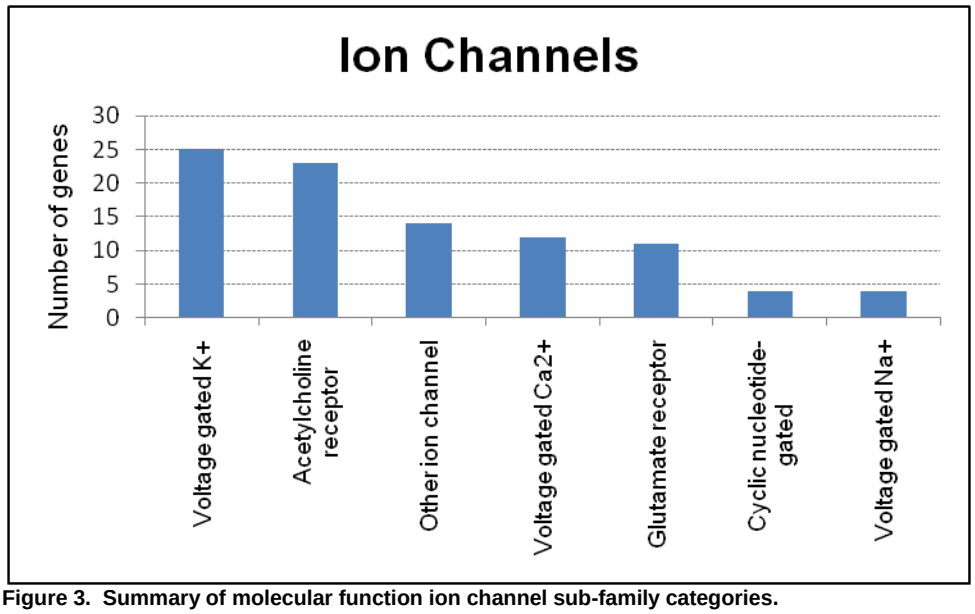

Figure 3. Summary of molecular function ion channel sub-family categories.

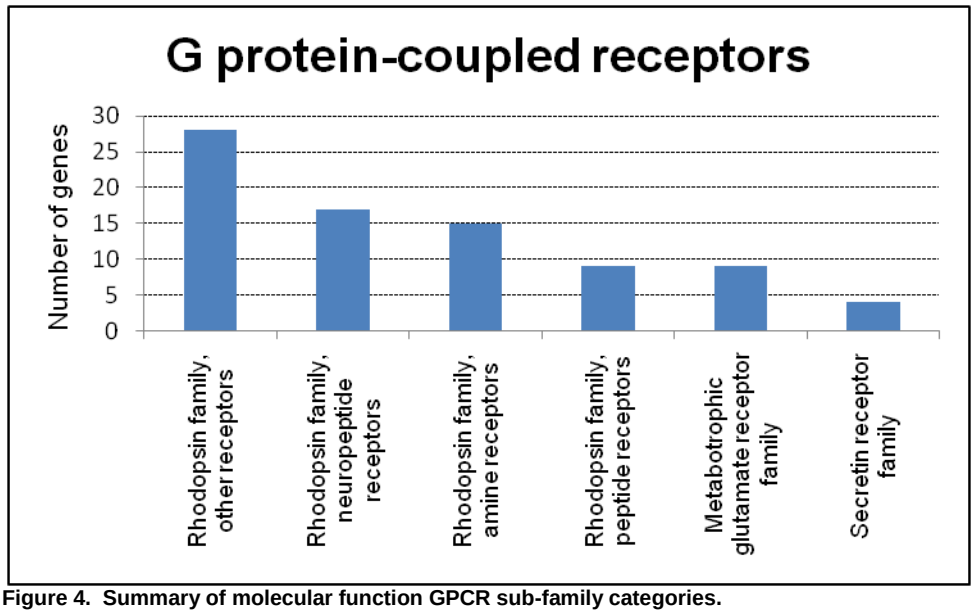

Figure 4. Summary of molecular function GPCR sub-family categories.

Summary

This analysis of the top 1,000 genes in the Atlas illustrates that the vast majority of gene expression data presented is similar to that of other public datasets and peer reviewed literature. We were able to directly compare 788 genes, and of these 758 (96%) were in general agreement with other sources. While not a comprehensive analysis of the more than 20,000 genes in the Atlas, this representative sub-sampling of the genes of greatest interest to the Neuroscience community provides important validation of the scientific accuracy of the Atlas dataset. In the small number of genes (30) where data was mismatching or not comparable, discrepancies are being investigated on a case-by-case basis for data improvement.

The PANTHER analysis provides a valuable assessment of the ontological categorization of the entire 1,000 gene dataset. It is not surprising that transcription factor, ion channel and G protein-coupled receptor families contain the greatest number of genes, as these represent three of the most extensively studied molecular families. The breakdown of these gene families into their sub-families offers a more specific categorization of some of the genes of greatest interest to the Atlas user community.

Table 2. A list of all genes for which a comparison was possible and the results of those comparisons. Genes are listed in order of greatest to fewest website hits. Literature references refer to the bibliography presented in the references section. "N/A" was used for genes for which a quality issue prohibited comparison with any external source. "Yes (d)" indicates that a gene was validated by comparison of developmental mouse data to external sources.

Gene Symbol	NCBI Entrez Gene ID	Comparison Outcome	Literature Reference	Matches Literature?	Matches BGEM?	Matches GENSAT ?
Th	21823	Validated	(Yamada et al., 1992)	Yes		
Drd2	13489	Validated	(Chen et al., 1991)	Yes		
Gad1	14415	Validated	(Ferraguti et al., 1990)	Yes		
Slc17a6	140919	Validated	(Hisano et al., 2000)	Yes		
Pvalb	19293	Validated	(Seto-Ohshima et al., 1989)	Yes		
Htr2c	15560	Validated	(Wright et al., 1995)	Yes		
Bdnf	12064	Validated	(Hofer et al., 1990)	Yes		
Crh	12918	Validated	(Chen et al., 2000)	Yes		

Calb1	12307	Validated	(Frantz and Tobin, 1994)	Yes		
Drd1a	13488	Validated	(Mansour et al., 1992)	Yes		
Gfap	14580	Validated	(Martin and O'Callaghan, 1995)	Yes		
Chat	12647	Validated	(Lauterborn et al., 1993)	Yes		
Npy	109648	Validated	(Gehlert et al., 1987)	Yes		
Cnr1	12801	Validated	(Moldrich and Wenger, 2000)	Yes		
Calb2	12308	Validated	(Resibois and Rogers, 1992)	Yes		
Slc17a7	72961	Validated	(Danik et al., 2005)	Yes		
Camk2a	12322	Validated	(Ochiishi et al., 1994)	Yes		
Nos1	18125	Validated	(Gotti et al., 2005)	Yes		
Penk	18619	Validated	(Zagon et al., 1994)	Yes		
Trh	22044	Validated	(Merchenthaler et al., 1988)	Yes		
Arc	11838	Validated	(de Foubert et al., 2007)	Yes		
Lepr	16847	Validated	(Huang et al., 1996)	Yes		
Crhr1	12921	Validated	(Van Pett et al., 2000)	Yes		
Cartpt	27220	Validated	(Koylu et al., 1998)	Yes		
Gal	14419	Validated	(Cheung et al., 2001)	Yes		
Foxp2	114142	Validated	(Ferland et al., 2003)	Yes		
Etv1	14009	Validated	(Yoneshima et al., 2006)	Yes		
Nts	67405	Validated	(Jennes et al., 1982)	Yes		
Tph2	216343	Validated	(Clark et al., 2006)	Yes		
Pomc	18976	Validated	(Gee et al., 1983)	Yes		
Sst	20604	Validated	(Zavitsanou et al., 2002)	Yes		
Wfs1	22393	Validated	(Takeda et al., 2001)	Yes		
Avp	11998	Validated	(Castel and Morris, 1988)	Yes		
Nes	18008	Mismatch	(Wei et al., 2002)	No	Not found	No
Pdyn	18610	Validated	(Lin et al., 2006)	Yes		
Slc17a8	216227	Validated	(Herzog et al., 2004)	Yes		
Dlk1	13386	Validated	(Jensen et al., 2001)	Yes		
Cck	12424	Validated	(Zavitsanou et al., 2002)	Yes		
Nr3c1	14815	Validated	(Tronche et al., 1999; Wei et al., 2004)	Yes		
Adcyap1	11516	Validated	(Kurrasch et al., 2007)	Yes (d)	Not found	Not found
Dcx	13193	Validated	(Yang et al., 2004)	Yes		
Prkcd	18753	Validated	(Garcia et al., 1993)	Yes		
Slc6a3	13162	Validated	(Shimada et al., 1992)	Yes		
Gabra6	14399	Validated	(Korpi et al., 1993)	Yes		
Grm5	108071	Validated	(Romano et al., 1995)	Yes		
Pax6	18508	Validated	(Stoykova and Gruss, 1994)	Yes		

Grm1	14816	Validated	(Shigemoto et al., 1992)	Yes		
Gria1	14799	Validated	(Martin et al., 1993)	Yes		
Tac1	21333	Validated	(Warden and Young, 1988)	Yes		
Ntrk2	18212	Validated	(Klein et al., 1990)	Yes		
Chrna7	11441	Validated	(Whiteaker et al., 1999)	Yes		
Mbp	17196	Validated	(Hartman et al., 1979)	Yes		
Grin1	14810	Validated	(Petralia et al., 1994)	Yes		
Reln	19699	Validated	(Ikeda and Terashima, 1997)	Yes		
Shh	20423	Validated	(Traiffort et al., 1999)	Yes		
Gpr161	240888	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Slc6a4	15567	Validated	(Bengel et al., 1997)	Yes		
Ngfr	18053	Validated	(Pioro and Cuello, 1990)	Yes		
Esr2	13983	Validated	(Shughrue et al., 1997a)	Yes	No	No
Adora2a	11540	Validated	(Svenningsson et al., 1999)	Yes		
Htr1a	15550	Validated	(Chalmers and Watson, 1991)	Yes		
Ache	11423	Validated	(Hoover et al., 1978)	Yes		
Drd3	13490	Validated	(Diaz et al., 1995)	Yes		
Tac2	21334	Validated	(Duarte et al., 2006)	Yes		
Glp1r	14652	Validated	(Larsen et al., 1997)	Yes		
Nrg1	211323	Validated	(Chen et al., 1994)	Yes		
Satb2	212712	Validated	(Nielsen et al., 2010)	Yes		
Gpr88	64378	Validated	(Mizushima et al., 2000)	Yes		
Glra1	14654	Validated	(Enz and Bormann, 1995)	Yes		
Nr4a2	18227	Validated	(Rojas et al., 2010)	Yes		
Gad2	14417	Validated	(Esclapez et al., 1994)	Yes		
Egr1	13653	Validated	(Knapska and Kaczmarek, 2004)	Yes		
Npy1r	18166	Validated	(Naveilhan et al., 1998)	Yes		
Trpc6	22068	Validated	(Kunert-Keil et al., 2006; Mizuno et al., 1999)	Yes		
Npsr1	319239	Validated	(Zhu et al., 2010)	Yes		
Tcf7l2	21416	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Mecp2	17257	Validated	(Shahbazian et al., 2002)	Yes		
Erbb4	13869	Validated	(Meyer et al., 1997)	Yes (d)	Not found	Not found
Dlx1	13390	Validated	(Saino-Saito et al., 2003)	Yes		
Neurod1	18012	Validated	(Munoz et al., 2007)	Yes		
Grin2b	14812	Validated	(Wenzel et al., 1997)	Yes		

Gjd2	14617	Validated	(Belluardo et al., 2000)	Yes		
Hcrt	15171	Validated	(Swanson et al., 2005)	Yes		
Cacna1g	12291	Validated	(Ernst et al., 2009)	Yes		
Dbh	13166	Validated	(Cimarusti et al., 1979)	Yes		
Kcnc1	16502	Validated		Not found	Yes	
Grin2a	14811	Validated	(Fleischmann et al., 2003)	Yes		
Ntn1	18208	Validated	(Livesey and Hunt, 1997)	Yes		
Cacng5	140723	Validated		Not found	Yes	
Gnrh1	14714	Validated	(Gill et al., 2008)	Yes		
Gabra1	14394	Validated	(Luntz-Leybman et al., 1995)	Yes		
Ghsr	208188	Validated	(Zigman et al., 2006)	Yes		
Gabrg1	14405	Validated	(Pirker et al., 2000)	Yes		
Ar	11835	Validated	(Simerly et al., 1990)	Yes		
Dkk3	50781	Validated	(Krupnik et al., 1999)	Yes		
Snca	20617	Validated	(Brenz Verca et al., 2003)	Yes		
Adra2a	11551	Validated	(Nicholas et al., 1993)	Yes		
Fos	14281	Validated	(Visel et al., 2004)	Yes		
Esr1	13982	Validated	(Shughrue et al., 1997b)	Yes		
Pcp4	18546	Validated	(Bulfone et al., 2004)	Yes	Not found	Not found
Gpr101	245424	Validated	(Bates et al., 2006)	Yes	Not found	Not found
Otx2	18424	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Cckbr	12426	Validated			Yes	
Agrp	11604	Validated			Not found	Yes
Prox1	19130	Validated	(Lavado and Oliver, 2007)	Yes	Not found	Not found
Gria2	14800	Validated	(Brene et al., 1998)	Yes	Not found	Not found
Nov	18133	Validated			Yes	
Pcp2	18545	Validated			Yes	
Slc1a2	20511	Validated	(Schmitt et al., 1996)	Yes	Not found	Not found
App	11820	Validated	(Kawarabayashi et al., 1991)	Yes	Not found	Not found
Ascl1	17172	Validated	(Parras et al., 2004)	Yes	Not found	Not found
Kcna1	16485	Validated	(Verma-Kurvari et al., 1997)	Yes	Not found	Not found
Chrm2	243764	Validated	(Vilaro et al., 1992)	Yes	Not found	Not found
Chrm1	12669	Validated			Yes	
Grp	225642	Validated			Yes	
Grin2c	14813	Validated	(Wenzel et al., 1997)	Yes	Not found	No
Kcnd2	16508	Validated			Yes	
Htr1b	15551	Validated	(Maroteaux et al., 1992)	Yes	Not found	No
Htr3a	15561	Validated			Yes	
Aqp4	11829	Validated	(Nagelhus et al., 2004)	Yes	Not found	Not found
Oprm1	18390	Validated	(Mansour et al., 1994)	Yes	Not found	Not found
Ntng1	80883	Validated		Not found	Yes (d)	Not found

Htr2a	15558	Validated			Yes	
Ntng2	171171	Validated			Yes	
Fabp7	12140	Validated			Not found	Yes
Per2	18627	Validated			Not found	Yes
Oxtr	18430	Validated	(Vaccari et al., 1998)	Yes	Not found	No
Efna5	13640	Validated	(Zarbalis and Wurst, 2000)	Yes	No	Not found
Gpr56	14766	Validated			Not found	Yes
Hcrtr1	230777	Validated			Not found	Yes
Dlg4	13385	Validated			Yes	
Rxfp3	239336	Validated			Yes	
Crlf1	12931	Validated			Yes	
Zic1	22771	Validated			Not found	Yes
Avpr1a	54140	Validated	(Ostrowski et al., 1994)	Yes	Not found	Not found
Ppp1r1b	19049	Validated			Not found	Yes
Ntrk1	18211	Validated			Yes	
Scn4b	399548	Validated	(Yu et al., 2003)	Yes	Not found	Not found
Crym	12971	Validated			Yes	
Slc32a1	22348	Validated		Not found	Yes (d)	Not found
Nefh	380684	Validated			Yes	
S100a10	20194	Validated			Yes	
Olig2	50913	Validated			No	Yes
Sparc	20692	Validated	(Mendis and Brown, 1994)	Yes	No	Not found
Lrrk2	66725	Validated			Not found	Yes
Mef2c	17260	Validated	(Lyons et al., 1995)	Yes	Not found	Not found
Slit1	20562	Validated	(Marillat et al., 2002)	Yes	Not found	No
Notch1	18128	Validated			Yes	
Gja1	14609	Validated			Yes	
Ddc	13195	Validated			Not found	Yes
Coch	12810	Validated			Not found	Yes
Drd4	13491	Mismatch	(Noain et al., 2006)	No	No	No
Fezf2	54713	Validated			Not found	Yes
Sema3a	20346	Validated			Yes	
Trhr	22045	Validated	(Calza et al., 1992)	Yes	Not found	No
Ntsr1	18216	Validated			Yes	
Man1a	17155	Validated			Yes	
Sox2	20674	Validated	(Brazel et al., 2005)	Yes	Not found	Not found
Grm3	108069	Validated			Yes	
Igfbp4	16010	Validated			Yes	
Chrna4	11438	Validated			Yes	
Chrna3	110834	Validated			Yes	
Gap43	14432	Validated			Yes	
Cacna1h	58226	Validated			Not found	Yes
Kit	16590	Validated			Yes	
Gabrg2	14406	Validated			Yes	
Plp1	18823	Validated		Not found	Yes (d)	Not found
Wnt5a	22418	Validated			Yes	
Actb	11461	Validated			Yes	
Nrp1	18186	Validated			Yes	

Prnp	19122	Validated		Not found	Yes (d)	Not found
Peg10	170676	Validated			Yes	
Gabra2	14395	Validated	(Takayama and Inoue, 2004; Visel et al., 2004)	Yes	Not found	Not found
Oxt	18429	Validated	(Castel and Morris, 1988)	Yes	Not found	Not found
Isl1	16392	Validated			Yes	
Gabra3	14396	Validated	(Pape et al., 2009)	Yes	Not found	Not found
Baiap3	545192	Validated			Not found	Yes
Fgfr1	14182	Validated			Yes	
Nnat	18111	Validated			Not found	Yes
Chrna6	11440	Validated			Not found	Yes
Mtap2	17756	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Egfr	13649	Validated	(Fox and Kornblum, 2005)	Yes	No	Not found
Calcr	12311	Validated			Not found	Yes
Trpc4	22066	Validated	(Fowler et al., 2007)	Yes	Not found	Not found
Itpr1	16438	Validated			Yes	
Rorb	225998	Validated			Yes	
Kcnq3	110862	Validated			Yes	
Ppfibp1	67533	Validated	(Chou et al., 2009)	Yes	No	Not found
Kcnk2	16526	Validated	(Talley et al., 2001)	Yes	Not found	Not found
Htr4	15562	Validated			Yes	
Foxo1	56458	Validated		Not found	Yes (d)	Not found
Sema3e	20349	Validated			Yes	
Gabra5	110886	Validated	(Malherbe et al., 1990)	Yes	Not found	Not found
Gabbr1	54393	Validated	(Lu et al., 1999)	Yes	Not found	No
Htr5b	15564	Validated			Yes	
Rgs4	19736	Validated			Not found	Yes
Irs4	16370	Validated			Not found	Yes
Calca	12310	Validated	(Terrado et al., 1997)	Yes	Not found	Not found
Zbtb20	56490	Validated			Yes	
Gfra1	14585	Validated			Yes	
Ndst4	64580	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Slit2	20563	Validated			Yes	
Trpv1	193034	Validated		Not found	Yes (d)	Not found
Cdhr1	170677	Validated			Yes	
Nmb	68039	Validated	(Wada et al., 1990)	Yes	No	Not found
Hcn2	15166	Validated			Not found	Yes
Ctgf	14219	Validated			Yes	
Cbln2	12405	Validated			Yes	
Nr3c2	110784	Validated			Yes	
Fmr1	14265	Validated	(Hinds et al., 1993)	Yes	No	No
Plcb1	18795	Validated			Yes	
Kcng4	66733	Validated			Not found	Yes
Snap25	20614	Validated			Not found	Yes
Gabbr2	242425	Validated			Yes	
Plxnd1	67784	Validated			Not found	Yes
Trpc5	22067	Validated	(Fowler et al., 2007)	Yes	Not found	Not found

Ttr	22139	Validated			Yes	
Hdc	15186	Validated			Yes	
Tacr3	21338	Validated			Not found	Yes
Nrgn	64011	Validated			Not found	Yes
Ngf	18049	Validated	(Lauterborn et al., 1995)	Yes	Not found	Not found
Kcnc3	16504	Validated	(Weiser et al., 1994)	Yes	Not found	Not found
Homer1	26556	Validated			Not found	Yes
Dcn	13179	Validated			Yes	
Slc6a5	104245	Validated			Yes	
Prokr2	246313	Validated			Yes	
Hap1	15114	Validated			Not found	Yes
Gpr50	14765	Validated			Yes	
Neurod6	11922	Validated	(Bartholoma and Nave, 1994)	Yes	Not found	No
Wnt1	22408	Mismatch	(Nichols and Bruce, 2006)	No	Not found	Not found
Kitl	17311	Validated			Yes	
Phox2b	18935	Validated			Yes	
Gabrd	14403	Validated	(Sinkkonen et al., 2004; Wisden et al., 1992)	Yes	Not found	Not found
Slc18a3	20508	Validated			Not found	Yes
Chrm4	12672	Validated	(Levey et al., 1991)	Yes	Not found	No
Glra3	110304	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Kcnma1	16531	Validated	(Knaus et al., 1996)	Yes	Not found	Not found
Pde10a	23984	Validated	(Seeger et al., 2003)	Yes	Not found	Not found
Efnb2	13642	Validated			Yes	
Grm8	14823	Validated		Not found	Yes (d)	Not found
Grm2	108068	Validated			Not found	Yes
Epha4	13838	Validated	(Mori et al., 1995)	Yes	Not found	No
Sirt1	93759	Validated			Yes	
Adcyap1r1	11517	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Htr2b	15559	Validated			Yes	
Chrnb2	11444	Validated		Not found	Yes (d)	Not found
Sim1	20464	Validated			Yes	
Lypd1	72585	Validated			Yes	
Ecel1	13599	Validated			Yes	
Lmo3	109593	Validated	(Hinks et al., 1997)	Yes	Not found	Not found
Pcdh20	219257	Validated			Yes	
Spp1	20750	Validated	(Shin et al., 1999)	Yes	Not found	No
Pnoc	18155	Validated			Not found	Yes
Igfbp5	16011	Validated			Yes	
Mc4r	17202	Validated			Yes	
Hdac6	15185	Validated			Yes	
Id2	15902	Validated	(Kitajima et al., 2006)	Yes	Not found	Not found
Rxfp1	381489	Validated	(Piccenna et al., 2005)	Yes	Not found	Not found
Chrna5	110835	Validated			Yes	
Cntnap2	66797	Validated			Yes	
Nefm	18040	Validated			Yes	

Esrrg	26381	Validated			Yes	
Tbr1	21375	Validated			Yes	
Scg2	20254	Validated			Yes	
Slc22a3	20519	Validated	(Amphoux et al., 2006)	Yes	Not found	No
Chrm5	213788	Validated	(Vilaro et al., 1990)	Yes	Not found	No
Chrm3	12671	Validated			Yes	
Npy2r	18167	Validated			Yes	
Amigo2	105827	Validated			Not found	Yes
Tiam1	21844	Validated			Yes	
Glra2	237213	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Dlx2	13392	Validated			Not found	Yes
Dsp	109620	Validated			Yes	
Foxp1	108655	Validated			Yes	
Cxcl12	20315	Validated	(Lu et al., 2002)	Yes	No	No
Cnr2	12802	Validated			Yes	
Gpr83	14608	Validated			Yes	
Igf1r	16001	Validated			Yes	
Gpr37	14763	Validated	(Marazziti et al., 1998)	Yes	Not found	No
Slc6a2	20538	Validated			Yes	
Gpx3	14778	Validated			Yes	
Gsk3b	56637	Validated		Not found	Yes (d)	Not found
Tubb3	22152	Validated	(Menezes and Luskin, 1994)	Yes	Not found	No
Gpr151	240239	Validated			Yes	
Id4	15904	Validated	(Kitajima et al., 2006)	Yes	No	No
Camk2d	108058	Validated			Yes	
Lhx6	16874	Validated			Yes	
Aldh1a1	11668	Validated			Yes	
Asb4	65255	Validated	(Li et al., 2005)	Yes	No	Not found
Magel2	27385	Validated			Not found	Yes
Slc30a3	22784	Validated	(Valente and Auladell, 2002)	Yes	Not found	Not found
Gpr26	233919	Validated			Yes	
Oprl1	18389	Validated	(Mollereau et al., 1994)	Yes	Not found	Not found
Robo1	19876	Validated	(Marillat et al., 2002)	Yes	Not found	Not found
Sema3f	20350	Validated			Yes	
Doc2b	13447	Validated	(Verhage et al., 1997)	Yes	Not found	Not found
Drd5	13492	Validated			Yes	
C1ql2	226359	Validated			Not found	Yes
Cux2	13048	Validated			Yes	
Cdh2	12558	Validated			Yes	
Lpl	16956	Validated			Not found	Yes
Slc6a1	232333	Validated			Yes	
Rtn4	68585	Validated	(Huber et al., 2002)	Yes	Not found	No
Galr1	14427	Validated	(Jungnickel et al., 2005)	Yes	No	No
Gpr12	14738	Validated	(Ignatov et al., 2003)	Yes	No	Not found
Dcc	13176	Validated			Yes	
Plagl1	22634	Validated	(Valente and Auladell, 2001)	Yes	Not found	Not found

Disc1	244667	Validated	(Austin et al., 2004)	Yes	Not found	Not found
Rgs9	19739	Validated			Yes	
Mapt	17762	Validated			Yes	
Kcnc2	268345	Validated			Yes	
Hrh3	99296	Validated			Yes	
Lmo4	16911	Validated			Yes	
Bmp4	12159	Validated			Yes	
Slc2a1	20525	Validated			Yes	
Vip	22353	Validated	(Miyoshi et al., 2010)	Yes	Not found	No
Slc18a2	214084	Validated			No	Yes
Cyp26b1	232174	Validated			Yes	
Kirrel3	67703	Validated	(Tamura et al., 2005)	Yes	Not found	Not found
Fstl1	14314	Validated			Yes	
Vegfa	22339	Validated			Yes	
Lhx2	16870	Validated		Not found	Yes (d)	Yes
Vipr2	22355	Validated			Not found	Yes
Hrh1	15465	Validated			Yes	
Ndn	17984	Validated			Yes	
Slc12a5	57138	Validated	(Kanaka et al., 2001)	Yes	Not found	No
Rora	19883	Validated	(Nakagawa et al., 1997)	Yes	No	Not found
Cd24a	12484	Validated		Not found	Yes (d)	Not found
Tnc	21923	Validated			Yes	
Rapgef4	56508	Validated			Yes	
Slc1a1	20510	Validated			Yes	
S1pr1	13609	Validated			Yes	
Trpv4	63873	Validated			Yes	
Park2	50873	Validated	(Wang et al., 2001)	Yes	Not found	Not found
Rgs16	19734	Validated			Yes	
Kcnj6	16522	Validated	(Saenz del Burgo et al., 2008)	Yes	Not found	Not found
Prom1	19126	Validated			Not found	Yes
Rtn4r	65079	Validated			Yes	
Grin2d	14814	Validated			Yes	
Cyp46a1	13116	Validated			Yes	
Gpr6	140741	Validated			Yes	
Sstr4	20608	Validated			Not found	Yes
Cdk5	12568	Validated			Yes	
Maob	109731	Validated			Yes	
Dlx5	13395	Validated			Yes	
Cdh11	12552	Validated			Not found	Yes
Sema7a	20361	Validated			Not found	Yes
Fxyd6	59095	Validated			Yes	
Nr2f2	11819	Validated	(Lopes da Silva et al., 1995)	Yes	Not found	No
Met	17295	Validated			Not found	Yes
Gabrb3	14402	Validated			Yes	
Maoa	17161	Validated	(Vitalis et al., 2002)	Yes	Not found	Not found
Igf2	16002	Validated			Yes	
P2rx7	18439	Validated	(Mochizuki et al.,	Yes	No	No

			1975)			
Ntf3	18205	Validated			Yes	
Apoe	11816	Validated			Yes	
Ptgds	19215	Validated			Not found	Yes
Agt	11606	Validated			Yes	
Mki67	17345	Validated			Not found	Yes
Nkx2-1	21869	Mismatch		Not found	No	No
Neto1	246317	Validated	(Michishita et al., 2003)	Yes	Not found	Not found
Efna3	13638	Validated			Yes	
Dner	227325	Validated	(Nishizumi et al., 2002)	Yes	Not found	Not found
Wif1	24117	Validated			Yes	
Clock	12753	Validated			Yes	
Nptx2	53324	Validated	(Tsui et al., 1996)	Yes	Not found	No
Cbln4	228942	Validated			Yes	
Gpr176	381413	Validated			Yes	
Stx1a	20907	Validated			Yes	
Gdnf	14573	Mismatch		N/A	N/A	N/A
Cxcl14	57266	Validated			Yes	
Grm4	268934	Validated			Yes	
Itgb1	16412	Validated	(Blaess et al., 2004)	Yes	Not found	Not found
Sema6a	20358	Validated			Yes	
Syt1	20979	Validated	(Marqueze et al., 1995)	Yes	No	Not found
Igf1	16000	Validated			Yes	
Etv5	104156	Validated			Yes	
Chrnb4	108015	Mismatch	(Gahring et al., 2004)	No	No	No
Hcrtr2	387285	Validated			Yes	
Prkca	18750	Validated			Yes	
Hes1	15205	Mismatch	(Stump et al., 2002)	No	Not found	No
En2	13799	Validated			Yes	
Wnt7b	22422	Validated	(Funatsu et al., 2004; Shimogori et al., 2010)	Yes (d)	No	Not found
Rarb	218772	Validated			Not found	Yes
Sox11	20666	Validated		Not found	Yes (d)	Not found
Epha7	13841	Validated			Yes	
Hsd11b1	15483	Validated			Not found	Yes (d)
Pvrl3	58998	Validated			Yes	
Sncg	20618	Validated			Not found	Yes (d)
Rprm	67874	Validated			Not found	Yes
Nlgn3	245537	Validated			Yes	
Plcb4	18798	Validated	(Tanaka and Kondo, 1994)	Yes	Not found	Not found
Nlgn1	192167	Validated			Yes	
Lrrtm1	74342	Validated			Yes	
Dock10	210293	Validated			Yes	
Nr2f1	13865	Validated	(Lopes da Silva et al., 1995)	Yes	No	Not found
Tgfb2	21808	Validated			Yes	
Adcy1	432530	Validated			Not found	Yes

Sirt2	64383	Validated			Yes	
Mchr1	207911	Validated			Yes	
Lhx8	16875	Validated			Yes	
Nr4a1	15370	Validated			Yes	
Crhr2	12922	Validated	(Chen et al., 2005)	Yes	Yes	No
Lhx1	16869	Validated			Yes	
Sox10	20665	Validated			Yes	
Stat3	20848	Validated			Not found	Yes
Rgs5	19737	Validated			Yes	
Erbb2	13866	Mismatch	(Fox and Kornblum, 2005)	No	No	Not found
6330527O06Rik	76161	Validated			Yes	
Adora1	11539	Validated	(Rivkees et al., 2000)	Yes	No	Not found
Vim	22352	Validated			Yes	
Lgals1	16852	Validated			Yes	
Wnt3	22415	Validated			Not found	Yes
Tcf4	21413	Validated			Yes	
Rbp4	19662	Validated			Not found	Yes
Ptpro	19277	Validated	(Kotani et al., 2010)	Yes	Not found	Not found
Ednrb	13618	Validated			Yes	
Glul	14645	Validated	(Lie-Venema et al., 1997)	Yes	No	Not found
Kiss1r	114229	Validated			Yes	
Astn2	56079	Validated			Yes	
Ntrk3	18213	Validated			Yes	
Kcnj9	16524	Validated	(Saenz del Burgo et al., 2008)	Yes	Not found	Not found
Ephb1	270190	Validated		Not found	Yes (d)	Not found
Lpar1	14745	Validated			Yes	
Gpr139	209776	Validated			Not found	Yes
Pten	19211	Validated			Yes	
Camk4	12326	Validated			Yes	
Kcnd3	56543	Validated	(Serodio and Rudy, 1998)	Yes	Not found	Not found
Gm10093	15181	Validated			Yes	
Kcnq2	16536	Validated	(Nakamura et al., 1998)	Yes	No	No
Uchl1	22223	Validated	(Misumi and Kawano, 1998)	Yes	Not found	No
Cdh8	12564	Validated		Not found	Yes (d)	Not found
Gda	14544	Validated			Not found	Yes
Gprc5b	64297	Validated			Yes	
Eomes	13813	Validated			Yes	
Gapdh	407972	Validated			Yes	
Robo2	268902	Validated			Yes	
Htr3b	57014	Mismatch		Not found	Not found	No
Park7	57320	Validated	(Bader et al., 2005)	Yes	Not found	Not found
Stmn1	16765	Validated			Yes	
Sox9	20682	Validated			Yes	
Egr2	13654	Validated	(Herdegen et al., 1993)	Yes	Not found	Not found

Syt9	60510	Validated			Yes	
Glrb	14658	Validated			Yes	
Kcnab1	16497	Validated	(Butler et al., 1998)	Yes	Not found	Not found
Gabre	14404	Validated	(Moragues et al., 2000)	Yes	Not found	Not found
Kcnc4	99738	Validated			Yes	
Ngb	64242	Validated	(Hundahl et al., 2010)	Yes	Not found	Not found
Ube3a	22215	Validated			Not found	Yes
Cacna2d1	12293	Validated			Yes	
Enpp2	18606	Validated			Yes	
Thbs4	21828	Mismatch	(Arber and Caroni, 1995)	No	Not found	No
Cnp	12799	Validated	(Peyron et al., 1997)	Yes	Not found	Not found
Calcb	116903	Validated			Not found	Yes
Adra2b	11552	Validated	(Wang et al., 1996)	Yes	No	Not found
Rgs8	67792	Validated			Yes	
Ncam1	17967	Validated			Yes	
Accn1	11418	Validated	(Visel et al., 2004)	Yes (d)	Not found	Not found
Cyp19a1	13075	Validated			Not found	Yes
Slc10a4	231290	Validated			Not found	Yes
Unc5d	210801	Validated	(Rowell et al., 2010)	Yes	No	Not found
Ryr1	20190	Validated			Yes	
Rasgrf1	19417	Validated			Yes	
Grik3	14807	Validated	(Tole et al., 2000)	Yes (d)	Not found	Not found
Kcnq5	226922	Validated			Yes	
Chrnb3	108043	Validated			Not found	Yes
Sdc3	20970	Validated			Not found	Yes
Sema3c	20348	Validated			Yes	
Prkcc	18752	Validated			Yes	
Grb10	14783	Validated			Yes	
Lxn	17035	Validated			Yes	
Lhx9	16876	Mismatch	(Nakagawa and O'Leary, 2001)	No	No	No
Klf10	21847	Validated	(Yajima et al., 1997)	Yes	Not found	No
Scn3b	235281	Validated			Yes	
Fibcd1	98970	Validated			Yes	
Tmem163	72160	Validated			Yes	
Odz3	23965	Validated			Yes	
Slitrk6	239250	Validated			Yes	
Zcchc12	72693	Validated			Yes	
Fn1	14268	Validated	(Sansom et al., 2009)	Yes (d)	Not found	No
Adcy5	224129	Validated	(Visel et al., 2006)	Yes	Not found	Not found
Slc6a11	243616	Validated			Yes	
Dab1	13131	Validated			Yes	
Gabrb2	14401	Validated	(Lolait et al., 1989)	Yes	Not found	No
Plekhg1	213783	Validated			Not found	Yes
Auts2	319974	Validated	(Bedogni et al., 2010)	Yes	Not found	Not found
Nog	18121	Validated			Yes	
Atp1a2	98660	Validated			Yes	
Nefl	18039	Validated			Yes	

Gucy2c	14917	Validated			Not found	Yes
Adra1d	11550	Validated			Yes	
Lhx5	16873	Validated			Yes	
Crim1	50766	Validated			Not found	Yes
Lgi1	56839	Validated			Yes	
Cacng2	12300	Validated			Yes	
Grid1	14803	Validated		Not found	Yes (d)	Not found
Ucn3	83428	Validated			Not found	Yes
Hdac5	15184	Validated			Yes	
Insr	16337	Validated			Yes	
Rgs10	67865	Validated			Yes	
3110035E14Rik	76982	Validated			Yes	
Lgr5	14160	Validated			Yes	
Gch1	14528	Validated			Yes	
Sv2c	75209	Validated	(Janz and Sudhof, 1999)	Yes	Not found	Not found
Lmx1b	16917	Validated	(Asbreuk et al., 2002)	Yes	Not found	Not found
Akt1	11651	Validated			Yes	
Kcnj10	16513	Validated			Yes	
Ano1	101772	Validated			Yes	
Eef1a1	13627	Validated			Yes	
Epha6	13840	Validated			Yes	
Agtr1a	11607	Validated			Yes	
L1cam	16728	Validated			Yes	
Homer2	26557	Validated			Yes	
Gabrb1	14400	Validated	(Zdilar et al., 1992)	Yes	Not found	Not found
Neurog2	11924	Validated	(Ozen et al., 2007)	Yes	Not found	No
Frzb	20378	Validated			Yes	
Dbi	13167	Validated			Not found	Yes
Opn3	13603	Validated			Yes	
Notch2	18129	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Synpo	104027	Validated			Yes	
Rgs14	51791	Validated	(Traver et al., 2000)	Yes	No	Not found
Oprk1	18387	Mismatch	(Kieffer and Evans, 2009)	No	No	No
Rgs2	19735	Validated			Yes	
Calm1	12313	Validated	(Sola et al., 1996)	Yes	No	Not found
Gng13	64337	Validated			Yes	
Prss12	19142	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Gls	14660	Validated			Yes	
Aldoc	11676	Validated			Yes	
Kcnj3	16519	Validated	(Kobayashi et al., 1995)	Yes	Not found	Not found
Lgi2	246316	Validated			Yes	
Chn2	69993	Validated			Yes	
Gpr155	68526	Validated	(Trifonov et al., 2010)	Yes	Not found	Not found
Fgf13	14168	Validated	(Smallwood et al., 1996)	Yes	Not found	No
Arx	11878	Validated	(Poirier et al., 2004)	Yes	Not found	No
Cort	12854	Validated			Yes	

Comt1	12846	Validated			Yes	
Chl1	12661	Validated			Yes	
Qrfpr	229214	Validated	(Takayasu et al., 2006)	Yes	Not found	Not found
Kcnab2	16498	Validated			Yes	
Bmp7	12162	Validated			Not found	Yes
Kcnh1	16510	Validated			Yes	
Pbx3	18516	Validated			Yes	
Meis2	17536	Validated			Yes	
Mc3r	17201	Validated	(Mounien et al., 2005)	Yes	Not found	No
Npy5r	18168	Validated	(Naveilhan et al., 1998)	Yes	No	Not found
Nrn1	68404	Validated			Yes	
Chgb	12653	Validated			Yes	
Igfbp3	16009	Validated			Yes	
Ptch1	19206	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Camk1g	215303	Validated			Yes	
Shank3	58234	Validated			Yes	
Plxna2	18845	Validated			Yes	
Dpysl3	22240	Validated	(Nacher et al., 2000)	Yes	No	Not found
Cst3	13010	Validated			Yes	
A930038C07Rik	68169	Validated			Not found	Yes
Mgll	23945	Validated			Not found	Yes
Gpr85	64450	Validated	(Matsumoto et al., 2005)	Yes	No	Not found
Gli1	14632	Validated			Yes	
Syt2	20980	Validated	(Berton et al., 1997)	Yes	No	Not found
Slc6a9	14664	Validated			Not found	Yes
Fezf1	73191	Validated			Not found	Yes
Npr1	18160	Validated			Yes	
Cacng7	81904	Validated			Yes	
Aldh1l1	107747	Validated			Yes	
Ephb2	13844	Validated			Yes	
Col6a1	12833	Validated			Yes	
Atxn1	20238	Validated	(Banfi et al., 1996)	Yes	Not found	Not found
En1	13798	Validated	(Simon et al., 2001)	Yes	No	No
Grin3b	170483	Validated			Yes	
Bcl11b	58208	Validated	(Britanova et al., 2008)	Yes	Not found	Not found
Slc6a15	103098	Validated			Yes	
Cdkn1a	12575	Validated			Yes	
Fgf2	14173	Mismatch		N/A	N/A	N/A
Rest	19712	Validated			Not found	Yes
Kcnk1	16525	Validated			Yes	
Olig1	50914	Validated			Not found	Yes
Ezh2	14056	Validated	(Sher et al., 2008)	Yes	Not found	Not found
Atf3	11910	Validated	(Francis et al., 2004)	Yes	No	Not found
Fzd3	14365	Validated			Yes	
Clu	12759	Validated			Yes	
Arnt2	11864	Validated	(Petersen et al., 2000)	Yes	Not found	Not found
Hpcal4	170638	Validated			Yes	
Ghrh	14601	Validated	(Acampora et al.,	Yes	No	Not found

			1999)			
Vcan	13003	Validated			Yes	
Mapk8	26419	Validated			Yes	
Icam5	15898	Validated			Not found	Yes
Srgap2	14270	Validated			Yes	
Meis1	17268	Validated	(Gray et al., 2004)	Yes	Not found	No
D0H4S114	27528	Validated			Not found	Yes
Camkk2	207565	Validated	(Sakagami et al., 2000)	Yes	Not found	No
Hpca	15444	Validated			Yes	
Serpini1	20713	Validated			Yes	
Cbln3	56410	Validated			Yes	
Notch3	18131	Validated			Not found	Yes
Btg1	12226	Validated			Yes	
Pitx2	18741	Validated			Yes	
Gsn	227753	Validated			Not found	Yes
Chd5	269610	Validated			Yes	
Dnmt1	13433	Validated			Not found	Yes
Cadm3	94332	Validated	(Thomas et al., 2008)	Yes	Not found	Not found
Thra	21833	Validated			Yes	
Cntn1	12805	Validated			Yes	
Grid2ip	170935	Validated	(Miyagi et al., 2002)	Yes	Not found	No
Gpr37l1	171469	Validated			Yes	
Slit3	20564	Validated			Yes	
Cd9	12527	Validated			Yes	
Nucb2	53322	Validated			Yes	
Npffr2	104443	Validated			Yes	
Otx1	18423	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Tnf	21926	Validated			Yes	
Cdh1	12550	Validated			Yes	
Resp18	19711	Validated			Yes	
Mapk3	26417	Validated			Yes	
Efnb3	13643	Validated		Not found	Yes (d)	Not found
Htr7	15566	Validated	(Ichikawa et al., 2005)	Yes	Not found	Not found
Cacng3	54376	Validated			Yes	
Ptpn5	19259	Validated			Yes	
Kcnj14	211480	Validated			Not found	Yes
Fyn	14360	Validated			Yes	
Dao	13142	Mismatch	(Ono et al., 2009)	No	Not found	Not found
Slc8a1	20541	Mismatch	(Wakimoto et al., 2001)	No	Not found	Not found
Cdk5r1	12569	Validated	(Visel et al., 2004)	Yes (d)	Yes (d)	No
Gprin1	26913	Validated	(Masuho et al., 2008)	Yes	Not found	Not found
Fgfr2	14183	Validated			Yes	
Fgfr3	14184	Validated			Yes	
Car12	76459	Validated			Yes	
Srr	27364	Validated			Yes	
Kcnip1	70357	Validated			Yes	
Btg2	12227	Validated			Not found	Yes
Sidt1	320007	Validated			Yes	

Kcnj4	16520	Validated			Yes	
Gjc1	14615	Validated			Yes	
Cd63	12512	Validated			Yes	
Adcy9	11515	Validated	(Visel et al., 2006)	Yes	Not found	Not found
Adra2c	11553	Validated			Yes	
Tle4	21888	Validated			Yes	
Gpr35	64095	Mismatch	(O'Dowd et al., 1998)	No	No	Not found
Slc6a7	240332	Validated			Yes	
Slc5a7	63993	Validated			Yes	
Dtnbp1	94245	Validated	(Kumamoto et al., 2006)	Yes	No	Not found
Sulf2	72043	Validated			Not found	Yes
Camk2b	12323	Validated			Yes	
Tnfrsf1a	21937	Validated			Yes	
Fev	260298	Mismatch		Not found	No	No
Cygb	114886	Validated	(Hundahl et al., 2010)	Yes	Not found	Not found
B2m	12010	Validated		Not found	No	Yes
Panx1	55991	Validated	(Ray et al., 2005)	Yes	Not found	Not found
Fzd1	14362	Validated		Yes	No	Not found
Atoh1	11921	Validated	(Akazawa et al., 1995)	Yes	Not found	No
Tmeff2	56363	Validated	(Kanemoto et al., 2001)	Yes	Not found	Not found
Neto2	74513	Validated			Yes	
Bcl6	12053	Validated			Yes	
Efr3a	76740	Validated			Not found	Yes
Kdr	16542	Validated			Yes	
Tyro3	22174	Validated			Yes	
Dusp6	67603	Validated			Yes	
Itpka	228550	Validated			Yes	
Synpr	72003	Validated	(Marqueze-Pouey et al., 1991)	Yes	Not found	Not found
Tgfb1	21803	Validated	(Bottner et al., 2000)	Yes	No	Not found
Olfm1	56177	Validated			Not found	Yes
Smoc2	64074	Validated			Yes	
Cplx3	235415	Validated			Not found	Yes
Cntfr	12804	Validated	(Dallner et al., 2002)	Yes	Not found	No
Npas2	18143	Validated			Yes	
Abat	268860	Validated	(Kang et al., 2001)	Yes	Not found	Not found
Bok	51800	Validated			Yes	
Gprin3	243385	Validated			Not found	Yes
Htr1d	15552	Validated	(Bruinvels et al., 1994)	Yes	No	No
Ngef	53972	Validated	(Yoshizawa et al., 2003)	Yes	Not found	Not found
Itgam	16409	Validated			Yes	
Mpped1	223726	Validated			Yes	
Chd7	320790	Validated			Yes	
Kcnj5	16521	Mismatch	(Wickman et al., 2000)	No	Not found	No
Vgf	381677	Validated	(Snyder and Salton, 1998)	Yes	Not found	Not found
Adcy2	210044	Validated			Yes	

Slitrk1	76965	Validated	(Beaubien and Cloutier, 2009)	Yes	No	Not found
Lef1	16842	Validated			Yes	
Gnas	14683	Validated			Yes	
Hrh2	15466	Validated			Yes	
Nova1	664883	Validated			Yes	
Pcp4l1	66425	Validated			Yes	
Foxa1	15375	Validated	(Wijchers et al., 2006)	Yes	No	Not found
Gnrhr	14715	Validated			Yes	
Chrna1	11435	Mismatch		N/A	N/A	N/A
Syp	20977	Validated	(Marqueze-Pouey et al., 1991)	Yes	Not found	Not found
Kcna4	16492	Validated	(Lujan et al., 2003)	Yes	Not found	No
Ccnd2	12444	Validated	(Kowalczyk et al., 2004)	Yes	Not found	No
P2ry12	70839	Validated			Yes	
Cacng8	81905	Validated			Yes	
Sema4g	26456	Validated	(Visel et al., 2004)	Yes (d)	No	Not found
Nrp2	18187	Validated			Yes	Not found
Stard5	170460	Validated			Not found	Yes
Mef2a	17258	Mismatch		N/A	N/A	N/A
Prkcz	18762	Validated			Yes	
Scg3	20255	Validated			Yes	
Npas3	27386	Validated	(Erbel-Sieler et al., 2004)	Yes	Not found	Not found
Mmp9	17395	Validated		Not found	Not found	Yes (d)
Cdkn1b	12576	Validated			Yes	
Hcn4	330953	Mismatch	(Brewster et al., 2007)	No	No	No
Egr3	13655	Validated	(Depaz et al., 2000)	Yes	Not found	Not found
Gpr171	229323	Validated			Yes	
B3galt2	26878	Validated			Not found	Yes
Kcnk9	223604	Mismatch	(Aller and Wisden, 2008)	No	Not found	Not found
Epha3	13837	Validated	(Kudo et al., 2005)	Yes (d)	No	Not found
Acvr1c	269275	Validated			Yes	
Cacng4	54377	Validated			Yes	
Stx3	20908	Validated		Not found	Yes (d)	Not found
Alk	11682	Validated			Yes	
Slco1c1	58807	Validated			Yes	
Wnt7a	22421	Validated		Not found	Yes (d)	No
Efna1	13636	Mismatch		Not found	No	No
Lynx1	23936	Validated			Yes	
Emx2	13797	Validated			Yes	
Hif1a	15251	Validated			Yes	
Pecam1	18613	Validated			Yes	
A2bp1	268859	Mismatch	(Kiehl et al., 2001)	No	Not found	Not found
Apc	11789	Validated	(Lee et al., 2010)	Yes	Yes (d)	Not found
Pde1b	18574	Validated			Not found	Yes
Kctd12	239217	Validated			Yes	
Cdh4	12561	Validated			Yes	

Emx1	13796	Mismatch		Not found	No	No
Pgrmc1	53328	Validated			Yes	
Lgi3	213469	Validated			Yes	
Flt1	14254	Validated			Yes	
Sez6	20370	Validated			Not found	Yes
Il1r1	16177	Validated	(Jafarian-Tehrani et al., 1998)	Yes	No	Not found
Psen1	19164	Validated	(Lee et al., 1996)	Yes	Not found	Not found
Mpdz	17475	Validated			Yes	
Gabarapl1	57436	Validated			Yes	
Dnmt3a	13435	Validated	(Feng et al., 2005)	Yes	Not found	No
Trpa1	277328	Validated			Yes	
Tgfa	21802	Validated			Yes	
Cux1	13047	Validated		Not found	Yes (d)	Not found
Mdk	17242	Validated			Not found	Yes
Zfhx3	11906	Validated	(Watanabe et al., 1996)	Yes	Not found	Not found
Arpp21	74100	Validated			Yes	
Ppp1r9a	243725	Validated			Yes	
Kcnk13	217826	Mismatch	(Aller and Wisden, 2008)	No	Not found	Not found
Gabarap	56486	Validated			Yes	
Cdh6	12563	Validated			Yes	
Ramp3	56089	Validated			Not found	Yes
S1pr5	94226	Validated			Yes	
Vamp2	22318	Validated			Yes	
Stim1	20866	Validated	(Skibinska-Kijek et al., 2009)	Yes	Not found	Not found
Tiam2	24001	Validated			Yes	
Cntn2	21367	Validated			Not found	Yes
Syt6	54524	Validated	(Rowell et al., 2010)	Yes	No	Yes
Stmn2	20257	Validated			Yes	
Gphn	268566	Validated			Yes	
Fasn	14104	Mismatch	(Kim et al., 2002)	No	Not found	Not found
Hspb1	15507	Validated	(Armstrong et al., 2001)	Yes	Not found	Not found
Lrrn1	16979	Validated			Yes	
P2ry14	140795	Validated			Yes	
Fgf1	14164	Validated			Yes	
Gpr3	14748	Validated			Yes	
Pacrg	69310	Validated	(Wilson et al., 2009)	Yes	Not found	Not found
Eno2	13807	Validated			Yes	
Sfrp2	20319	Validated	(Kim et al., 2001)	Yes	No	Not found
Pcdh17	219228	Validated	(Kim et al., 2010)	Yes	Not found	Not found
Sp8	320145	Validated			Yes	
Gpr4	319197	Validated			Yes	
Pde9a	18585	Validated	(Andreeva et al., 2001)	Yes	Not found	Not found
Cacna2d2	56808	Validated			Yes	
Avpr1b	26361	Validated	(Young et al., 2006)	Yes	No	Not found
Sigmar1	18391	Mismatch	(Seth et al., 2001)	No	Not found	Not found

Dusp1	19252	Validated			Yes	
Sema6d	214968	Validated	(Shimogori et al., 2010)	Yes (d)	Not found	No
Cyr61	16007	Validated	(Visel et al., 2004)	Yes (d)	Not found	No
Scn10a	20264	Validated			Yes	
Hdac2	15182	Mismatch	(Broide et al., 2007)	No	Not found	Not found
Id3	15903	Validated			Yes	
Negr1	320840	Validated			Yes	
Trpm2	28240	Validated	(Kraft et al., 2004)	Yes	Not found	Not found
F2r	14062	Validated	(Zhou et al., 2009)	Yes	No	No
Cryab	12955	Validated			Yes	
Chn1	108699	Validated			Yes	
Nrip3	78593	Validated			Not found	Yes
Moxd1	59012	Validated			Yes	
Sox14	20669	Validated			Not found	Yes
Bcan	12032	Validated			Not found	Yes
Ncor1	20185	Validated		Not found	Yes (d)	No
Pak7	241656	Validated	(Li and Minden, 2003; Pandey et al., 2002)	Yes	Not found	Not found
Gpr125	70693	Validated	(Pickering et al., 2008)	Yes	Not found	Not found
Csf2rb2	12984	Validated			Not found	Yes
Slc16a1	20501	Validated	(Koehler-Stec et al., 1998)	Yes	Not found	Not found
Cyp2f2	13107	Mismatch		N/A	N/A	N/A
Cspg4	121021	Validated			Yes	
Slc2a3	20527	Validated			Yes	

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