Gene Expression Profiles from Peripheral Blood Mononuclear Cells Are Sensitive to Short Processing Delays

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In the analysis of peripheral blood gene expression, timely processing of samples is essential to ensure that measurements reflect *in vivo* biology, rather than *ex vivo* sample processing variables. The effect of processing delays on global gene expression patterns in peripheral blood mononuclear cells (PBMCs) was assessed by isolating and stabilizing PBMC-derived RNA from 3 individuals either immediately after phlebotomy or after a 4 h delay. RNA was labeled using NuGEN Ovation labeling and probed using the Affymetrix HG U133 Plus 2.0 GeneChip[®]. Comparison of gene expression levels (\geq 2-fold expression change and *P* < 0.05) identified 307 probe sets representing genes with increased expression and 46 indicating decreased expression after 4 h. These differentially expressed genes include many that are important to inflammatory, immunologic, and cancer pathways. Among others, *CCR2*, *CCR5*, *TLR10*, *CD180*, and *IL-16* have decreased expression, whereas *VEGF*, *IL8*, *SOCS2*, *SOCS3*, *CD69*, and *CD83* have increased expression after a 4 h processing delay. The trends in expression patterns associated with delayed processing times. These data indicate that the time between sample acquisition, initiation of processing, and when the RNA is stabilized should be a prime consideration when designing protocols for translational studies involving PBMC gene expression analysis.

Introduction

BIOBANKING PRACTICES REQUIRE support from evidencebased biospecimen science to ensure that findings are due to *in vivo* biological differences rather than *ex vivo* influences. This is especially important in global gene expression studies such as those using Affymetrix GeneChips[®] that monitor the expression level of ~47,000 transcripts from a single sample and can be highly sensitive to preanalytical variability.

Although several studies have examined the effect of preanalytical variables on global gene expression in solid tissues^{1–3} (among others), much less is known concerning the effect of delayed isolation of peripheral blood mononuclear cells (PBMCs). In one study comparing aliquots of PBMCs processed immediately or after overnight shipping to a single processing center, 2034 out of 6414 genes were found differentially expressed.⁴ Independently, Affymetrix, Inc., identified extensive expression pattern changes in PBMC samples due to overnight processing delays.⁵

In this study we identified gene expression changes in PBMCs related to processing delays as short as 4h. These patterns were also apparent in an independent set of 276 arrays with variable processing times.

Materials and Methods

Subjects

Blood samples from adult volunteers were used to examine the processing time variable directly. In addition, data were available from a large, multicenter, gene expression study related to juvenile idiopathic arthritis (JIA). Patients in the JIA study were followed for up to 2 years and blood samples were collected at up to 10 time points for each patient. Blood was collected after informed consent.

Sample processing

Sample processing has been detailed elsewhere.^{6–8} Briefly, peripheral blood was collected in acid citrate dextrose (ACD) tubes, and PBMCs were isolated over Ficoll gradient (Ficoll PaqueTM Plus; GE Healthcare, Piscataway, NJ) and put into TRIzol[®] reagent (Invitrogen, Carlsbad, CA) for 5 min at room temperature before slow cooling ($-1^{\circ}C/min$), and storage at $-80^{\circ}C$. The time between phlebotomy and start of processing is defined as the "processing delay." The time between phlebotomy and storage at $-80^{\circ}C$ is defined as "time to freezing" (TTF). RNA was extracted and purified using

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RNeasy columns (Qiagen, Germantown, MD). cDNA was prepared using NuGEN Ovation kit version 1 (NuGEN Technologies, San Carlos, CA) from 100 ng of RNA and assayed using Affymetrix HG U133 Plus 2.0 GeneChips (Affymetrix, Santa Clara, CA). The timecourse microarray dataset has been deposited in the Gene Expression Omnibus at the National Center for Biotechnology Information (NCBI) and is accessible through GEO Series access number GSE21039.

Statistical analysis

Data were preprocessed in GeneSpring GX 7.3.1 using robust multichip analysis.⁹ Probe sets representing differentially expressed genes were defined as those with \geq 2-fold expression difference and *P* < 0.05. Hierarchical clustering used Pearson correlation for probe sets and distance correlation for samples. To allow comparison to probe sets reported in the literature using an earlier version GeneChip, a conversion was performed using the GeneSpring 7.3 "translate" function.

Results

Short processing delays alter gene expression

Three tubes of blood were collected from a single venipuncture from each of 3 donors, and PBMCs were isolated after a 0 h (T0), 2 h (T2), or 4 h (T4) delay at room temperature. Comparing GeneChip signal intensity values between T0 and T4 identified 353 probe sets detecting differentially expressed genes (select probe sets in Table 1, and full list in the Appendix. Hierarchical clustering of the samples using these probe sets completely segregated the samples into their respective processing-time category (Fig. 1A).

 TABLE 1.
 Selected Genes of Immunological Importance

		Fold change ^b	
Probe ID ^a	Gene symbol ^a	2 h/0 h ^c	4 h/0 h ^d
207794_at	CCR2	0.63	0.38
206991_s_at	CCR5	0.53	0.39
223751_x_at	TLR10	0.64	0.45
216379_x_at	CD24	0.55	0.45
206206_at	CD180	0.61	0.47
209828_s_at	IL16	0.67	0.47
223583_at	TNFAIP8L2	0.60	0.47
207907_at	TNFSF14	0.62	0.49
227697_at	SOCS3	1.71	2.14
218881_s_at	FOSL2	1.69	2.16
209795_at	CD69	1.60	2.23
230170_at	OSM	2.26	2.29
218311_at	MAP4K3	1.55	2.40
201465_s_at	JUN	1.33	2.41
203373_at	SOCS2	1.53	2.50
202644_s_at	TNFAIP3	2.30	2.79
211506_s_at	IL8	2.27	3.23
217738_at	PBEF1	2.04	3.31
204440_at	CD83	2.20	3.47
210512_s_at	VEGF	1.89	3.48

 $^{\mathrm{a}}\mathrm{Affymetrix}$ U133 Plus 2.0 GeneChip® probe set IDs and annotations.

^bFold change as ratio of geometric means.

Expression at 2h/expression at 0h.

^dExpression at 4 h/expression at 0 h.

Response to overnight processing delays is different

In a previous report, Baechler et al. identified 2155 probe sets (2082 HG U133 Plus 2.0 equivalents) measuring differentially expressed genes between peripheral bloods processed to PBMCs immediately and those bloods shipped by overnight courier before processing.⁴ Understanding that there were significant experimental differences between the 2 studies, the current list of 353 probe sets was compared and showed only 62 probe sets (17%) in common. Although there were clusters of genes that appeared different in samples with delayed processing, the 2082 probe sets were unable to distinguish the current samples according to processing time (Fig. 1B).

Validation in a larger cohort

To determine whether the processing time signature would be apparent in samples that exhibit variation in gene expression for other reasons, the expression pattern (shown as the average of the expression levels for observation purposes) was examined in an independent group of 276 arrays (Fig. 2). The PBMC samples were obtained either from healthy controls or from patients with JIA and TTF ranged from 60 to 315 min. Although these samples showed some variation (possibly indicating biological variation between samples), trends of expression changes due to processing time were evident (Fig. 2). The trend was apparent in samples from each clinical site and each disease subtype showing that the processing time effect is independent of either clinical site or disease state (data not shown).

Discussion

Many studies have reported gene expression differences in PBMCs without providing details of sample processing procedures. This study highlights the importance of considering processing delays since periods as short as 4 h can have significant effects on gene expression. While additional studies with independent samples are necessary to define specific processing gene expression signatures, it is clear that processing delays must be considered in experimental design and data interpretation.

This study was not designed to determine the specific cause of the identified gene expression changes although several explanations can be hypothesized. Phlebotomy itself can have an influence on lab results obtained from blood samples.¹⁰ Regarding storage of samples after phlebotomy, a previous study looked at the effect of room temperature storage of serum and plasma.¹¹ Within 4h after phlebotomy, the environment of the plasma and serum sample changed significantly, which would cause biological stresses. Glucose levels dropped, lactate increased, pH decreased, and hypoxia were identified by a decrease in pO₂ and an increase in pCO₂. Although this study did not examine the effect of blood processing delays, it can be expected that similar effects would be encountered. Even the simple preanalytical variables of the additive in the collection tube (eg, ACD in this study) or interaction of cells with the surface of the tube itself (a significant change from the vasculature of the donor) for several hours may cause the identified gene expression changes.

Proteins derived from the genes listed in Table 1 are important in inflammatory, autoimmune, and cancer pathways.



FIG. 1. Processing effects of gene expression signatures. (**A**) Samples clustered according to 353 probe sets identified (P < 0.05 and fold-change ≥ 2 -fold) representing genes differentially expressed between samples processed immediately or after a 2 or 4 h delay. (**B**) Samples from this study were clustered according to gene expression data related to 2082 probe sets identified by Baechler et al. as differentially expressed after overnight shipment of peripheral blood before RNA extraction.⁴ Each column represents 1 sample and each row represents 1 probe set. In the heatmap, expression levels are indicated by color (yellow, median; red, increased; blue, decreased). Bar at the bottom indicates class membership: red, immediate processing; yellow, 2 h delay; blue, 4 h delay. See online article at www.liebertonline.com for color figure.

Vascular endothelial growth factor (VEGF) is a prototypical angiogenic factor,¹² and anti-VEGF has become the standard treatment for many tumor types.¹³ CCR2, CCR5, and IL-8 are chemoattractants that activate and recruit immune cells to sites of infection and inflammation. Antagonists to CCR2 have been suggested as therapy for a variety of inflammatory diseases as well as obesity and pulmonary disease.¹⁴ The CCR5 (also called CD195) antagonist, Maraviroc, is currently



FIG. 2. Average expression levels of time-sensitive probe sets. In a pilot experiment, 307 probe sets were identified with increased expression and 46 with decreased expression after a 4 h processing delay. Average expression of probe sets with increased (solid line) or decreased (dotted line) expression is shown in 267 independent samples. Samples are arranged according to time to processing.

approved for treatment of HIV infection.¹⁵ SOCS2 and 3 are key negative regulators of cytokine signaling.¹⁶ TLR10 and CD180 (RP105) are involved in toll-like receptor signaling. The fact that these genes have variable expression attributable to processing delays emphasizes the importance of attention to preanalytic variables in sample collection and processing, a fundamental component of biospecimen science.

Various strategies can be employed to address possible changes caused by processing delays. The method we chose to reduce the impact of this variable was to remove samples with extended processing times (>4h) from analysis.^{6–8} As an alternative, time-sensitive genes may be removed from consideration.¹⁷ Both of these methods have the benefit of simplicity although specific cutoffs are arbitrary. A disadvantage of this approach is that time-sensitive genes might also be involved in pathogenic processes. An interesting, but untested, method would be to delay processing of all samples until a specified time postphlebotomy (eg, 2h) to reduce this variability. Alternatively, statistical approaches such as linear modeling may be employed using processing time as 1 variable.

To avoid the effect of variable processing time, technologies that stabilize samples instantly have been developed. These methods collect whole blood, including neutrophils that tend to vary in number more than other cellular components, and metabolically active immature red blood cells. Together, these components may overshadow more biologically relevant PBMCs. Additionally, there are issues with the so-called globin effect, where excessive amounts of globin mRNA derived from the reticulocytes present in whole blood interfere with the microarray analysis as seen by decreased present calls.⁵ It is unclear if this occurs due to inhibition during the labeling or probing steps of the assay. Newer labeling systems may help overcome this issue (as indicated by recovery of detected genes; unpublished data).

It is evident from this study that processing delays affect gene expression patterns obtained from PBMCs in a very short period. It is, therefore, important for this variable to be measured so that its effect can be considered in data interpretation.

Acknowledgments

This work was supported by the NIH/National Institute of Arthritis and Musculoskeletal and Skin Diseases (Grants P01AR048929, P30AR047363, and P60AR047784), the Cincinnati Children's Hospital Research Foundation, and the Ohio Valley Chapter of the Arthritis Foundation.

Author Disclosure Statement

No competing financial interests exist.

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Received 29 March, 2010/Accepted 3 May, 2010

		Fold	change ^b
Probe ID ^a	Gene symbol	$2 h/0 h^{c}$	4 h/0 h ^d
204622_x_at	NR4A2	5.2877	8.9551
216248 s at	NR4A2	5.4105	8.8413
205239 at	AREG///LOC653193	4.6343	8.1447
36711 at	MAFF	4.7111	7.0973
213933 at	PTGER3	3 2406	6 4005
219312 s at	ZBTB10	2 7223	5 8898
202464 s at	PEKEB3	3 266	5 8/83
202404_5_at	SNE11 K	4 1568	5 8328
200070_5_at	JULI	2 0190	5.0520 E 9209
200957_5_at		2 1592	5.6206
203621_{at}	DEE1 ///DD11 00110 4	2 0120	5.7492
217739_S_at	$\Gamma DE \Gamma 1 / / / K \Gamma 11 - 92 J 19.4$	2.9129	5.6232 E 4029
1554509_at	EIF4G5	2.6247	5.4238
209967_s_at		3.4671	5.2409
233899_x_at	ZBIBIU	2.4014	5.2317
228562_at	_	2.901	5.2283
213524_s_at	G0S2	3.772	5.1801
207630_s_at	CREM	3.5328	5.1701
224454_at	ETNK1	2.8282	5.1389
230511_at	CREM	3.7946	5.1284
204621_s_at	NR4A2	3.235	5.0914
214508_x_at	CREM	3.4216	5.049
222309_at	C6orf62	2.4626	4.8293
219228_at	ZNF331	2.6557	4.6216
218880_at	FOSL2	2.8545	4.4736
222180_at	YES1	2.5314	4.4144
240038_at	ELL2	2.6019	4.3908
202861_at	PER1	2.6954	4.3866
201466_s_at	JUN	1.781	4.2976
204141_at	TUBB2A	2.7917	4.231
202859_x_at	IL8	2.5225	4.0768
241740_at	CREM	3.5468	3.9794
227613_at	ZNF331	2.4938	3.8653
1552908_at	C1orf150	2.6113	3.7847
38037_at	HBEGF	2.1529	3.771
225262_at	FOSL2	2.8867	3.7097
201464_x_at	JUN	1.9194	3.6948
205548_s_at	BTG3	2.2915	3.6902
236495_at	PBEF1	1.6075	3.6901
233952_s_at	ZNF295	1.9552	3.5791
1562255_at	SYTL3	2.335	3.5712
1559975_at	BTG1	2.4178	3.5277
210512_s_at	VEGF	1.8886	3.4847
204440_at	CD83	2.1959	3.4748
228062_at	NAP1L5	2.3574	3.4686
230133_at	MNAB	2.5067	3.4311
203543_s_at	KLF9	2.1823	3.4159
222044_at	_	2.2031	3.3953
1554036_at	ZBTB24	2.772	3.3849
225884_s_at	ZNF336	2.2638	3.3824
204286_s_at	PMAIP1	1.8584	3.3814
242712_x_at	LOC653086///LOC653489///LOC653596	1.8887	3.3689
1556361_s_at	ANKRD13C	1.8804	3.3257
1568665_at	RNF103	2.2975	3.3193
213134_x_at	BTG3	2.2166	3.3135
1557257_at	BCL10	2.1335	3.3121
217738_at	PBEF1	2.0389	3.3118
1569136_at	MGAT4A	2.4002	3.3043
231182_at	WASPIP	2.2977	3.2973
242243_at	TMF1	1.5683	3.2954
222815_at	RNF12	1.7508	3.2557
211506_s_at	IL8	2.2651	3.2343
			(continued)

Appendix. Three Hundred Fifty-Three Probe Sets Indicating Genes with Differential Expression Between To and T4 Samples

Appendix. (Continued)

		Fold change ^b	
Probe ID ^a	Gene symbol	2 h/0 h ^c	4 h/0 h ^d
60084 at	CYLD	1.862	3.2292
210837_s_at	PDE4D	1.9635	3.2114
202643_s_at	TNFAIP3	2.5643	3.2094
241985_at	JMY	1.8644	3.2086
1555476_at	IREB2	2.5553	3.2083
211458_s_at	GABARAPL1///GABARAPL3	2.2323	3.1766
203574_at	NFIL3	2.0392	3.1158
219622_at	RAB20	1.7122	3.0976
1569263_at	SLC16A3	2.0431	3.0744
218319_at	PELI1	1.9741	3.0721
208869_s_at	GABARAPL1	1.8508	3.0551
242903_at	IFNGR1	1.5903	3.044
243664_at	TXNL1	1.6132	3.0196
232044_at	RBBP6	2.0252	3.0159
225539_at	ZNF295	1.8582	3.0102
219094_at	ARMC8	1.8875	3.001
226370_at	KLHL15	2.0354	2.997
202672_s_at	ATF3	1.4894	2.9967
233127_at	ZNF331	1.7927	2.9944
221986_s_at	KLHL24	1.8226	2.966
1555167_s_at	PBEF1	2.0741	2.9628
1554306_at	ПРКВ	2.1793	2.9596
228063_s_at	NAP1L5	2.3632	2.959
243857_at	MORF4L2	1.3143	2.9586
229718_at	CG018	2.0091	2.949
238796_at	YTHDC1	1.9338	2.9354
233309_at	TMEM2	2.0113	2.9252
203372_s_at	SOCS2	2.0505	2.9183
202558_s_at	SICH	1.7833	2.8712
235592_at	ELL2	1.6639	2.8409
1553134_s_at	C9orf/2	1.7996	2.8148
202932_at	YESI	1.6396	2.8141
205214_at	STK1/B	2.1198	2.7996
1555963_x_at	B3GN17	1.9141	2.7986
204285_s_at	PMAIP1	1.6905	2.795
1553861_at	ICPIIL2	1.8632	2.7942
231990_at	USP15	1.945	2.7884
202644_s_at	INFAIP3	2.3037	2.7877
211924_s_at	PLAUK	1.6585	2.7822
226608_at	LOC388272	1.8214	2.7687
213281_at		1.3926	2.7683
242176_at	MEF2A DUCD10	1.8/62	2.7647
221363_at	DUSPIU	1.4304	2.7587
202499_s_at	SLC2A3	1.9353	2.7522
1556259_a_at	HEKPUD2 DICA	2.0926	2.7401
205281_s_at	PIGA MVD1	1.7789	2.738
228846_at		1.838	2.7347
209345_s_at		1.703	2.7331
210845_s_at		1.7088	2.7207
220101_at	JLCJUAI 7DTD14	1.4327	2.7179
1004007_a_at	ZDID24 MED25 ///METPNIL ///LOC652506	2.2392	2.7114
223935_at	TNE420	2.1320	2.0070
222024_5_at	MCC14276	2.203	2.0007
214090_at	MGC14570 MVD1	2.0027	2.0701
220275_ai		1.7707	2.0704
209000_5_at 218/86_at	KI F11	1.0000	2.0439
210700_at	CEL 2	1 8000	2.041
22-1002_5_al 2028/3_at	DNAIB9	1.0777 1.8760	2.0398 2.6357
202040_at		1,0707	2.0207
227309_at 222142_at		1.0190	2.0100
222142_at 227718_at	PURB	1.0020	2.0102 2.4145
22//10_dl		1.0072	L.0140
			(communell)

DELAYED PROCESSED

Appendix. (Continued)

		Fold change ^b	
Probe ID ^a	Gene symbol	2 h/0 h ^c	4 h/0 h ^d
1555274 a at	SELI	1.6311	2.6088
225557 at	AXUD1	2.1334	2.5998
213758 at	COX4I1	2,1092	2,5914
203751 x at	IUND	1.9964	2.5908
202988 s at	RCS1	1 8381	2 5897
1555281 x at	ARMC8	1.0001	2.5897
$210836 \times 2t$	PDF4D	1.0012	2.5004
210000_{A} at		1.9552	2.5710
204014_at		1.7219	2.3012
225950_at	SAMDo	1.7527	2.555
228962_at	— A TD2/C1	2.4/11	2.552
21113/_s_at	AIPZCI	1.00	2.5507
209457_at	DUSP5	2.352	2.5505
209020_at	C20orf111	1.869	2.5422
230134_s_at	MNAB	1.9244	2.5405
202241_at	TRIBI	1.5014	2.539
230802_at	—	1.8712	2.5229
207361_at	HBP1	1.972	2.5225
202393_s_at	KLF10	1.7447	2.5212
1555962_at	B3GNT7	2.053	2.5179
218009_s_at	PRC1	1.7305	2.5112
203373_at	SOCS2	1.5295	2.5006
222088_s_at	SLC2A3	2.0713	2.4999
202498_s_at	SLC2A3	1.9717	2.499
1553133 at	C9orf72	1.7513	2.4989
234993 at	ABHD13	1.8074	2.4978
238389 s at	_	1.6874	2.4961
204958 at	PLK3	2 0159	2 4923
224739 at	PIM3	1 8682	2 4803
1557285 at	LOC653193	1.5002	2.1000
211302 s at	PDF4B	2 606	2.1700
211502_5_at	I DETD	1 557	2.4007
242009_at	EDDEI1	2 1002	2.4004
22407_dt		2.1792	2.4029
225364_5_at	KD1DD2	1.7043	2.4309
232370_at		1.9100	2.4410
239143_X_at	KINF130 DLIC2	1.652	2.4353
1552644_a_at	PRUS	1.8204	2.4195
235780_at	PKKACB	1.7088	2.4114
201465_s_at	JUN	1.3337	2.4088
206374_at	DUSP8	1.7425	2.4062
218311_at	MAP4K3	1.5526	2.4006
226811_at	FAM46C	2.115	2.3995
1554549_a_at	WDR20	1.9178	2.3993
211423_s_at	SC5DL	1.8531	2.3989
1557459_at	SNF1LK2	1.5047	2.395
216834_at	RGS1	1.7235	2.3864
213805_at	ABHD5	1.4863	2.3721
201195_s_at	SLC7A5	1.6834	2.372
37028_at	PPP1R15A	1.4221	2.3542
203542_s_at	KLF9	1.4991	2.3531
212665_at	TIPARP	1.8848	2.346
243463 s at	RIT1	1.3348	2.3438
229899 s at	HSUP1	1.8462	2.3411
215501 s at	DUSP10	1.484	2.3342
224797 at	ARRDC3	1.8174	2.3328
201745 at	РТК9	1.8115	2.3255
224453 s.at	ETNK1	1.4933	2 3238
215889 at	SKIL	1.3378	2 3207
230170 at	OSM	2 265	2.0207
226345 at		1.67	2.2923
$2200 \pm 0_{at}$	DIT1	1 1062	2.2714
230223_5_a		1.1705	2.2090
$20 \pm 707_{\rm A}_{\rm al}$		1.0470	2.2041
200731_5_at	F1F4A1	1.011	2.2023
			(continued)

Appendix. (Continued)

Probe ID ^a	Gene symbol	Fold change ^b	
		$2 h/0 h^{c}$	4 h/0 h ^d
202497 x at	SLC2A3	2	2.2822
216236_s_at	SLC2A3	2.0204	2.2787
214326_x_at	JUND	1.697	2.2744
202014_at	PPP1R15A	1.4726	2.2677
204908_s_at	BCL3	1.824	2.2656
206877_at	MXD1	1.9677	2.2589
201751_at	JOSD1	1.8399	2.2569
214007_s_at	PTK9	2.2865	2.2558
209383_at	DDIT3	1.4827	2.2509
219624_at	BAG4	1.4673	2.2485
1560/39_a_at	UBE3C	1.6187	2.2419
225283_at	ARRDC4	1.5707	2.2404
209694_at	P15	1.7733	2.2386
225954_s_at	MIDN CD60	1.4918	2.23/3
209795_at	CD09 CD2	1.3999	2.2349
236035_at	SFS CZorf40	1.7000	2.2321
225099_at 206919_at	EI KA	1.091	2.231
200919_at	KI F5	1.00	2.2007
208868 s at	GABARAPL1	1.0001	2.2250
223746 at	STK4	1.3786	2.2227
204299 at	FUSIP1///LOC642558	1.4299	2.2204
202657 s at	SERTAD2	1.5966	2.2196
244103 at	Clorf55	1.4718	2.2185
243371_at		1.2476	2.217
219382_at	SERTAD3	1.5925	2.2096
1559582_at	RHOQ	1.634	2.2063
227979_at	RBM4B	1.6985	2.2013
227521_at	FBXO33	2.0717	2.2007
205241_at	SCO2	1.6203	2.1977
205409_at	FOSL2	1.9516	2.1974
201170_s_at	BHLHB2	1.5799	2.1973
230380_at	THAP2	1.646	2.1963
226732_at	RBM33	1.6297	2.1953
36829_at	PERI	1.5855	2.1948
220330_s_at	SAMSNI	1.4587	2.1929
1555279_at	ARMC8	1.5154	2.1899
1559121_S_at	AKIHZ ZNE226	1.7207	2.1012
22/680_at	ZINF320 DTD4 & 1	1.000	2.1762
200735_5_at	IRS2	1.401	2.1739
20100_5_at	TMEM59	1.0135	2.1743
213538 at	SON	1.7747	2.1732
201502 s at	NFKBIA	1 8469	2.1713
1556750 at	LOC153577	1.4175	2.1679
1554469 at	BTBD15	1.355	2.1672
212373 at	FEM1B	1.7173	2.1652
203659_s_at	RFP2	1.6565	2.1647
223527_s_at	CDADC1	1.5857	2.1636
229955_at	FBXO3	1.553	2.1617
218881_s_at	FOSL2	1.6893	2.1598
226650_at	ZFAND2A	1.7917	2.1594
230304_at	_	1.6304	2.1564
202083_s_at	SEC14L1	1.3439	2.1561
204244_s_at	DBF4	1.5495	2.1544
200730_s_at	PTP4A1	1.6072	2.1488
221727_at		1.6197	2.1482
235670_at	STX11	1.3933	2.1472
221919_at		1.5308	2.1456
209300_s_at	NECAPI	1.6498	2.1448
218940_at	CI4ort138 CRDC ///CRDCR	1.6503	2.1436
1004009_s_at	SDDS/// SDDSL	1.6481	2.1423
			(continuea)

Appendix. (Continued)

Probe Gene symbol 2 h0hf 4 h0hf4 20748, at. SUC16A6 16/12 2.141 216075, at. SIFX 16/78 2.141 216075, at. CIAS1 1.7/15 2.138 22607.41 SOCS3 1.7/13 2.1387 23803, at. ING3 1.585 2.1324 238719, at. - 1.471 2.1335 23803, at. ING3 1.585 2.1249 238719, at. CDNNIA 1.5662 2.1259 214491, at. CDENIA 1.6666 2.1259 214835, at. CDNNIA 1.5662 2.1259 214805, at. COENIA 1.5664 2.1219 212405, at. COENIA 1.5664 2.1219 212405, at. COENIA 1.5676 2.1235 214000, at. AMYLA///SBP1 1.5767 2.1235 21400, at. CLRP7 1.4444 2.119 22405, at. CLRP7 1.4446 2.1138 215705 </th <th></th> <th></th> <th colspan="2">Fold change^b</th>			Fold change ^b	
220784.st SLC16A6 16/12 2.141 22069.s_at SBDS 16/38 2.141 21601.s_at CIAS1 7.7515 2.138 21607.s_at CIAS1 1.7515 2.138 215457.ut APBBILP 1.5464 2.1357 215457.ut APBBILP 1.5487 2.1324 2287.j.at CDKN1A 1.5562 2.1324 2287.j.at CDKN1A 1.6065 2.1256 21439.j.at CDKN1A 1.6065 2.1256 220360.s_at FAM46C 1.8422 2.125 21400.dt AWT1A///SBP11 1.877 2.1225 21405.j.at ZNF36 1.5654 2.1215 21405.j.at ZNF36 1.5654 2.1215 21405.j.at LART 1.876 2.1122 21405.j.at LART 2.141 2.141 212260.j.at HWTA///SBP1 1.8756 2.1225 2400.dt LART 2.141 2.141 21246.j.at HWTA 1.756 2.1225 24050.j.at HWTA	Probe ID ^a	Gene symbol	$\frac{1}{2 h/0 h^c}$	4 h/0 h ^d
222669 5.at SBDS 1.6738 2.14 222607 At SOCS3 1.7134 2.1335 227607 At SOCS3 1.7134 2.1335 221635 At ING3 1.582 2.1335 231833 At ING3 1.582 2.1335 231847 At PDEID 1.8871 2.1221 201491 At PDEID 1.8871 2.1221 201294 At INCAMOP 1.5052 2.1231 202540 At INCAMOP 1.5055 2.1231 212400 At INCAMOP 1.5055 2.1231 212400.1 ANYIA INCAMOP 1.5056 2.1214 212400.2 At PDIMAC 1.1566 2.1195 214000.2 At INCAMOP 1.5654 2.1214 212405.2 At ALMSI 1.1565 2.1195 2134055.4 At ALMSI 1.1565 2.1195 21355.4 IARYP 1.4494 2.1195 226603.at IAR	230748_at	SLC16A6	1.6112	2.1411
216015_at CIASI 1.7615 2.138 216012.st APBBIIP 1.5946 2.1357 155457Lat APBBIP 1.5946 2.1324 238719 at — 1.471 2.1317 238719 at — 1.471 2.1324 238719 at PDE4D 1.8871 2.1229 218379_at RBM7 1.5762 2.1241 212345_s_at CDKN1A 1.0065 2.1236 220306_at FAM46C 1.4422 2.125 220305_at DCC440309 1.3305 2.1241 212460 at AMY1A//SSBP1 1.676 2.1225 214850 at ARP7 1.4664 2.119 226803_s.at CCCC50 1.4426 2.118 226907_at FPO11 1.2186 2.118 226907_at FRX033 1.6576 2.1023 244219_at WTAP 1.7064 2.1063 21985_at HR1A 1.4106 2.118 22690_at GL728D1 1.4775 2.1223 244219_at WTAP 1.7084<	222669_s_at	SBDS	1.6738	2.14
227697_at SOCS3 1.7134 2.135 1554571_at APBBIIP 1.5946 2.1335 231863_at ING3 1.582 2.1324 2318471_at PDF4D 1.8871 2.1251 231847 AT 1.1315 2.1252 231847 BMT 1.5762 2.1261 23036_at FAM46C 1.4422 2.125 23036_at FAM46C 1.4422 2.125 24030_at FAM46C 1.4422 2.125 24055_s_at LOC440309 1.5305 2.1401 1556911_at AMY1A///SBP1 1.4757 2.1225 24055_s_at ZAP53 2.1405 2.111 1.5664 2.1121 156901_at ALMF1 1.1506 2.1138 1.4765 2.1123 24055_s_at CCDC50 1.4426 2.1181 2.1666 2.1123 241848_at ITO11 1.2166 2.1138 2.1668 2.1123 24429_at WTAP 1.7064 2.	216015 s at	CIAS1	1.7615	2.1398
1554571_at APBBIP 1.5946 2.1354 238719.at ING3 1.582 2.1324 238719.at PDEAD 1.4871 2.1325 23873.p.at RBM7 1.5762 2.1261 218357.at CDKNIA 1.0065 2.1256 223030.c.at LOC440309 1.5305 2.1241 212400.at AMMIA///SSBP1 1.4757 2.1225 234055.s_at ZNA306 1.5654 2.1211 212400.at AMMIA///SSBP1 1.4757 2.1225 234055.s_at ZNA336 1.5654 2.1211 214080.at LART7 1.4494 2.119 241385.at LART7 1.4494 2.119 24438.at IPO11 1.2186 2.1181 22490.at HIFTA 1.4106 2.1083 21429.at WTAP 1.0084 2.1008 21429.at MTAP 1.4086 2.1008 21429.at MAFK 1.7076 2.0094 21998.at HIFTA 1.4106 2.1087 21998.at MAFK	227697_at	SOCS3	1.7134	2.1357
21863.a ^t ING3 1.582 2.1324 238719.at — 1.471 2.1315 218491.at PDEAD 1.8871 2.1272 218491.at PDEAD 1.8871 2.1261 202306.at FAM46C 1.4422 2.125 20306.at FAM46C 1.4422 2.125 212400.s_at PIK3RI 1.756 2.1235 214005.s_ot CDKV1A 1.0744039 1.5365 2.1241 21405.s_ot ZUR33.at IA757 2.1225 2.1235 21405.s_ot ZUR33.at IA757 2.1225 2.135 2.1121 1.5661 2.1191 1556911.at ALART7 1.4444 2.119 2.1666 2.1132 2.1242 2.1123 2.1242 2.1135 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1124 2.1144 2.1168 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1123 2.1124 2.1124 2.1123	1554571_at	APBB1IP	1.5946	2.1335
23870 at — 1471 2.1315 218379 at RBM7 1.5762 2.1261 218379 at CDKN1A 1.6065 2.1256 220306, at FAM46C 1.8422 2.125 226830 x, at LOC440309 1.5305 2.1241 212406, at AMY1A///SSBP1 1.8757 2.1255 23035 s, at ZN053 1.5654 2.111 155611, at ALM51 1.1536 2.1192 23893, at CCDC50 1.4426 2.1181 238488, at IPO11 1.2186 2.1138 238493, at GL72D1 1.4785 2.1123 228697, at FRX033 1.6576 2.1123 228697, at GL72D1 1.4785 2.1138 228697, at GLAS5 2.1123 2.1249 228697, at GLAS5 2.1123 2.1249 228697, at GLAS5 2.1123 2.1249 228697, at HJR3B 1.8988 2.1008 21998, at HIFLA 1.406 2.1081 21998, at HJR4D	231863_at	ING3	1.582	2.1324
204491 nt PDEAD 1.8871 2.1279 208379. at RBM7 1.5762 2.1261 202306. at FAM46C 1.8422 2.125 20306. at FAM46C 1.8422 2.125 20306. at PAM46C 1.8422 2.125 21240. S., at PIK3RI 1.756 2.1235 21406. at AMY1A///SSBP1 1.8757 2.1235 21405. s. at ZNP336 1.5654 2.1211 155911. at ALMS1 1.1336 2.1195 214385. at LAR77 1.4494 2.1195 28488. at IPO11 1.2186 2.1131 28488. at IPO11 1.2186 2.1127 24429. at WTAP 1.7084 2.1003 24429. at WTAP 1.7084 2.1003 21998. at HIF1A 1.4106 2.1018 21998. at H373B 1.8988 2.1008 21998. at H373B 1.8998 2.1008 21998. at H373B 1.8988 2.1008 21998. at	238719 at	_	1.471	2.1315
218379_at RB/7 1.5762 2.1261 202345_s_at CDKN1A 1.6065 2.125 20305 at FAM46C 1.8422 2.125 20305 at LOC(440309 1.5305 2.1241 212445_g_at PKSR1 1.756 2.1235 214060 at AMY1A///SSBP1 1.8757 2.1225 234055_s_at ZNF336 1.5654 2.111 1556911_at ALM51 1.1536 2.1195 234053_st CCDC500 1.4426 2.1181 236970_at FBK033 1.6576 2.1123 224970_at WTAP 1.7084 2.1063 226970_at HDTA 1.4785 2.1123 24297a_t WTAP 1.7084 2.1063 20698_at HDTA 1.406 2.1085 212290_at MTAF 1.4266 2.1085 21235 2.0946 1.13736 2.1086 212405_at MAFK 1.2022 2.0946 21277 2.0466 2.0487 2.0497 212465_at MAFK 1.2	204491_at	PDE4D	1.8871	2.1279
20224, s.at CDKN1A 1.6065 2.1256 20306, at FAM46C 1.8422 2.125 226300, x.at LOC440309 1.5305 2.1241 22240, S.at PKSRI 1.756 2.1235 21400, at AMY1A///SSBP1 1.8757 2.1235 21405, S.at ZNP336 1.5654 2.1211 155011, at ALMS1 1.1336 2.1195 214385, at LARP7 1.4494 2.119 228488, at IPO11 1.2186 2.1138 228488, at GL12SD1 1.4426 2.1181 228488, at HFIA 1.4106 2.1003 24429, at WTAP 1.7084 2.1003 24429, at HIFIA 1.4106 2.1008 21998, at HJS73B 1.8998 2.1008 218708, at HJS73B 1.8998 2.1008 218708, at HJS73B 1.2272 2.0946 226206, at MAFK 1.7076 2.0094 226	218379 at	RBM7	1.5762	2.1261
220306 at FAMAGC 1.8422 2.125 226830, x_at LOC(440309 1.5305 2.1241 121240, s_at PIKSRI 1.756 2.1235 214060, at AMY1A///SSBP1 1.8757 2.1235 125691, at ALMSI 1.1536 2.1191 125691, at ALMSI 1.1336 2.1192 226053, at CCDC50 1.4426 2.1181 226970, at FBNO33 1.6576 2.1123 226970, at GUZSD1 1.4785 2.1123 226970, at GUXSD1 1.6576 2.1123 226970, at GUXSD1 1.6576 2.1123 22409, at MTAP 1.108 2.1063 20989, at HIFLA 1.406 2.1085 21996, at MAFK 2.1026 2.0944 15752 2.0946 1.5252 2.0947 157429_at GUNS 1.2975 2.0946 21580, at MAFK 1.2925 2.0966 219464	202284 s at	CDKN1A	1.6065	2.1256
228830.x at LOC440309 13305 2.1215 21240.x at PIK3R1 1.756 2.1235 21406.at AMV1A///SSBP1 1.8757 2.1225 21405.s_at ZNF336 1.3654 2.1211 1356911.at ALMS1 1.1556 2.1195 21485.s_at ZNF336 1.4424 2.119 21486.at IPO11 1.2186 2.1181 228693.at CCDC50 1.4425 2.1181 224805.s_at GCDC50 1.4426 2.1181 224805.at HF0X033 1.6576 2.1127 222808.at GLZ8D1 1.4755 2.1235 220089.at HF1A 1.4106 2.1018 21996.at HS7B 1.8898 2.1008 21870.s_at NAT 1.6555 2.0987 21870.s_at MAFK 1.976 2.0044 21870.s_at MAK 1.925 2.0887 21860.at MAFK 1.925 2.0887 21860.at	220306 at	FAM46C	1.8422	2.125
212240 Cart PICRT 1756 21235 214060.at AMY1A ///SSBP1 13757 21235 214050.at CNP336 13554 21211 15691.at ALMS1 11536 2195 21895.at LARP? 14444 2119 22808.at CCDC50 14426 21138 22808.at IPO11 12186 21132 22808.at GIT28D1 14785 21123 22405.at GASS 21222 2208 21998.at HIF1A 14106 21018 21998.at HIF1A 14106 21018 21998.at HIF1A 14106 20098 21998.at HIF1A 14106 20098 21998.at NXTI 14555 20998 21998.at HIF1A 14106 20018 21992.at KIAA0999 15522 2087 215429.at KIAA0999 15522 2087 215448.at MASTI 1302	226830 x at	LOC440309	1.5305	2.1241
21406.0.at AMYLA///SSBP1 1877 2122 214055.s.at ZNF3.s.at 21211 1156911.at ALMS1 1.356 2.1211 12807.s.at LARI7 1.4494 2.195 214385.at LARI7 1.4494 2.195 21486.at IPO11 1.2186 2.1181 28488.at IPO11 1.2186 2.1181 28488.at IPO11 1.2186 2.1182 22809.at GL72811 1.4755 2.1127 222808.at GL72811 1.4755 2.1068 21998.at HBF3B 1.4898 2.1008 218705.s.at GNAS 1.2272 2.0946 218705.s.at GNAS 1.2272 2.0946 21877.s.at IPPIRI6B 1.522 2.0887 21860.at MAFK 1.3985 2.0086 21846.at MACA//NACAPI//LOC389240 1.6582 2.0181 214840.at NURFI 1.3985 2.0664 213577.at EVC	212240 s at	PIK3R1	1.756	2.1235
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	214060 at	AMY1A ///SSBP1	1 8757	2 1225
155911_at ALMS1 11536 21195 241385_at LARP7 1.4494 2119 241385_at CCDC50 1.4426 2.1181 25869_at IPO11 1.2186 2.1182 25848_at IPO11 1.2186 2.1127 228687_at FBX033 1.6576 2.1127 222808_at GL128D1 1.4785 2.1063 20098_at HIFIA 1.4106 2.1018 20989_at H373B 1.8898 2.1008 218706_at NAFK 1.7076 2.0946 242975_s.at GNAS 1.2272 2.0876 226306_at MAFK 1.7076 2.0946 215929_at K1AA0999 1.5522 2.0887 212666.at SMURF1 1.3925 2.0866 218810_at Z.2412A 1.7462 2.082 218810_at CCA///NACAP1///LOC389240 1.682 2.0819 21337_at HLA-DPA1 1.6066 2.0813 213605_at CFL1 2.0007 2.081 22757_at EXOCS	234055 s at	ZNF336	1.5654	2 1211
241385.atLARP71.44942.119228693.atCCDC501.44942.119228693.atCCDC501.44262.1181228670.atFBX0331.65762.112322808.atGLT28D11.47852.1123241219.atWTAP1.70842.106321998.atHIF1A1.41062.101821998.atHIF1A1.41062.101821998.atHJB7B1.89882.1008218708.atNXT11.65952.0998226206.atMAFK1.77762.09441577.atPPP1R16B1.52252.0887155429.atKIAA09991.55222.0887155429.atSMURP11.39852.0086228466.atSMURP11.39852.0866228465.atMASTI.1.30222.08521337.atHLA-DPA11.60662.081322630.atCFL22.0072.08122337.atHLA-DPA11.60662.081324630.atCFL22.0072.08124535.atCFL22.0072.08124535.atCFL22.0072.08124630.atCFL22.06742.063224639.atCFL22.07642.062124639.atCFL21.62692.067524639.atCFL21.62692.067524639.atCFL21.62692.067524639.atCFL21.62642.069225490.atCFL21.62642.0692 <t< td=""><td>1556911 at</td><td>AI MS1</td><td>1 1536</td><td>2 1195</td></t<>	1556911 at	AI MS1	1 1536	2 1195
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	241385 at	I ARP7	1 4494	2.1190
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	228693 at	CCDC50	1 4426	2.119
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	238/88 at	IPO11	1 2186	2.1101
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	226970 at	FBYO33	1.2100	2.1130
222000 diff diff diff diff diff 220080 at HIFIA 1.7084 2.1063 200980 at HIFIA 1.4106 2.1018 219956 at HS73B 1.8898 2.1008 218708 at NXTI 1.6595 2.0998 218705 s.at GNAS 1.2272 2.0946 226206.pt MAFK 1.7976 2.0904 41577.at PPPRI6B 1.522 2.0887 218666.at SMURFI 1.3022 2.085 228468.at MASTL 1.3022 2.085 218810.at ZC3H12A 1.7462 2.082 228463.at CFL2 2.0077 2.081 224663 s.at CFL2 2.0079 2.081 226630.at STARD4 1.5828 2.0764 227577_at EXOC8 1.6527 2.0717 206644_s.at DNAJB1 1.8485 2.0665 286333.at <td>220970_at</td> <td>CI T29D1</td> <td>1.0570</td> <td>2.1127</td>	220970_at	CI T29D1	1.0570	2.1127
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	222000_{al}		1.4703	2.1123
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	244219_{at}		1.7004	2.1003
$\begin{array}{llllllllllllllllllllllllllllllllllll$	200989_at	HIF1A LIOFOD	1.4106	2.1018
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	211998_at	H3F3D NIVT1	1.8898	2.1008
24297.5_at GNAS 1.2272 2.0940 26206_at MAFK 1.7976 2.0904 41577_at PPP1R16B 1.5225 2.0887 1554929_at KIAA0999 1.5522 2.0872 212666_at SMURF1 1.3985 2.0866 228468_at MASTL 1.3022 2.0852 218810_at CGN12A 1.7462 2.082 22018 at NACA///NACAP1//LOC389240 1.6582 2.0813 22463_s_at CFL2 2.0207 2.081 22630_at STARD4 1.5828 2.0764 22630_at STARD4 1.5828 2.0689 227577_at EXOC8 1.6527 2.0717 20064 s_at DNAJB1 1.8485 2.0689 204799_at ZBED4 1.6269 2.0675 238633_at EPC1 1.6999 2.0655 238455_at - 1.6264 2.0598 20341_s_at DC646725///LOC649431 1.6368 2.0629 20343_s_at ENC1 1.9072 2.0516 204370_at	218/08_at		1.6595	2.0998
226200_att MAPK 1.7970 2.0904 1577_at PPIR16B 1.5225 2.0872 155492_at KIAA0999 1.5522 2.0872 212666_at SMURF1 1.3985 2.0866 228468_at MASTL 1.3022 2.085 218610_at ZC3H12A 1.7462 2.082 21810_at NACA///NACAP1//LOC389240 1.6582 2.0819 213537_at HLA-DPA1 1.6066 2.0813 226390_at STARD4 1.5828 2.0764 226390_at STARD4 1.5828 2.0689 204799_at ZBED4 1.6269 2.0675 28180_at SMU1 1.6351 2.0689 204799_at ZBED4 1.6269 2.0675 28180_at SMU1 1.6351 2.0689 20479_at LOC646725//LOC649431 1.6368 2.06065 281455_at — 1.6264 2.0593 204370_at HEAB 1.7027 2.0516 204370_at ENC1 1.6368 2.0429 20666_s_at	242975_s_at	GNAS	1.2272	2.0946
4157/atPPTR1681.52252.08871554929_atKIAA09991.55222.0872212666_atSMURF11.39852.0866228468_atMASTL1.30222.08521810_atZC3H12A1.74622.08221251337_atNACA//NACAP1//LOC3892401.65822.0819213537_atHLA-DPA11.60662.081322463_s_atCFL22.0072.08122690_atSTARD41.56282.076422757_atEXOC81.65272.071720064_s_atDNAJB11.84852.0689204799_atZBED41.62692.0675288633_atEPC11.69992.065528180_atSMU11.63512.063420169_s_atBHLHB21.71682.062129944_atLOC646725//LOC6494311.63682.0608204370_atHEAB1.70272.0513204370_atHEAB1.70272.0513204370_atHEAB1.69982.0331204370_atHEAB1.69732.037221276a_atSFPQ1.55092.0339204370_atHEAB1.62762.034220561_s_atDNAJB11.63732.037221276a_atFEM1B1.69982.038120239_atRAD23B1.62762.034222595_1_s_atLOC440309//LOC649081.55992.035921276a_atPDE4B2.05922.034222555_s_atWDR371.27232.0258<	226206_at	MAFK DDD1D1CD	1.7976	2.0904
153492_at KIAA099 1.5522 2.0872 212666_at SMURF1 1.3985 2.0866 228468_at MASTL 1.3022 2.085 218610_at ZC3H12A 1.7462 2.082 222018_at NACA///NACAP1//LOC389240 1.6582 2.0819 213537_at HLA-DPA1 1.6066 2.0813 226630_at STARD4 1.5828 2.0764 226390_at STARD4 1.5828 2.0764 226390_at STARD4 1.5828 2.0764 227577_at EXOC8 1.6527 2.0717 200664_s.at DNAJB1 1.8485 2.0689 204799_at ZBED4 1.6269 2.0675 23833_at EPC1 1.6999 2.0655 228180_at SMU1 1.6351 2.0624 29345_s.at P14KII 1.5147 2.0621 293494_at LOC646725///LOC649431 1.6368 2.0608 238450_at — 1.6264 2.0598 201341_at ENC1 1.9072 2.0513 20450_at <td>41577_at</td> <td>PPP1R16B</td> <td>1.5225</td> <td>2.0887</td>	41577_at	PPP1R16B	1.5225	2.0887
212666_at SMUK1 1.3985 2.0885 228468_at MASTL 1.3022 2.085 218810_at ZC3H12A 1.7462 2.082 213337_at HLA-DPA1 1.6066 2.0813 224663_s_at CFL2 2.0207 2.081 224663_s_at CFL2 2.0207 2.081 226390_at STARD4 1.5828 2.0764 226377_at EXOC8 1.6527 2.0717 20064_s_at DNAJB1 1.8485 2.0689 227577_at EXOC8 1.6527 2.0717 20064_s_at DNAJB1 1.8485 2.0635 238633_at EPC1 1.6269 2.0675 238633_at EPC1 1.6351 2.0634 20140_s_at SMU1 1.6351 2.0634 20345_s_at PI4KII 1.5147 2.0621 239449_at LOC64675///LOC649431 1.6368 2.0429 20347_at ENC1 1.9072 2.0533 201341_at ENC1 1.9072 2.0533 20466_s_at DNAJB1<	1554929_at	KIAA0999	1.5522	2.0872
228468_at MAS1L 1.3022 2.085 218810_at ZC3H12A 1.7462 2.082 222018_at NACA///NACAP1///LOC389240 1.6582 2.0819 213537_at HLA-DPA1 1.6066 2.0813 22663_s_at CFL2 2.0207 2.081 22639_at STARD4 1.5828 2.0764 227577_at EXOC8 1.6527 2.0717 20664_s_at DNAJB1 1.8485 2.0689 204799_at ZBED4 1.6269 2.0675 238633_at EPC1 1.6999 2.0655 28180_at SMU1 1.6351 2.0633 201945_s_at BHLHB2 1.7168 2.0629 209345_s_at PI4KII 1.5147 2.0621 29944_at LOC646725//LOC649431 1.6368 2.0688 201341_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0516 236196_at — 1.5068 2.0429 20239_at KLHL7 1.5973 2.0372 20239_at	212666_at	SMURFI	1.3985	2.0866
$\begin{array}{llllllllllllllllllllllllllllllllllll$	228468_at	MASTL	1.3022	2.085
222018_atNACA///NACAP1///LOC3892401.65822.0819213537_atHLA-DPA11.60662.081322663_s_atCFL22.02072.08122639_atSTARD41.58282.0764227577_atEXOC81.65272.071720664_s_atDNAJB11.84852.0689204799_atZBED41.62692.0675238633_atEPC11.69992.0655238633_atSMU11.63512.063420149_s_atBHLHB21.71682.062529345_s_atP14KII1.51472.062129494_atLOC64675///LOC6494311.63682.0008238455_at-1.62642.0593204370_atHEAB1.70272.0516236196_at-1.50682.042920066_s_atDNAJB11.68742.039120239_atKLHL71.59732.037221768_atSFPQ1.55092.035923598_atRAD23B1.62762.0342225951_s_atLOC440309//LOC6499081.59412.0342225951_s_atLOC440309//LOC6499081.59412.032520564_atSERAC11.36742.02111569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.499920470_atKLAA08590.62410.4969	218810_at	ZC3H12A	1.7462	2.082
$\begin{array}{llllllllllllllllllllllllllllllllllll$	222018_at	NACA///NACAP1///LOC389240	1.6582	2.0819
224663_s_atCFL22.02072.081226390_atSTARD41.58282.0764227577_atEXOC81.65272.0717200664_s_atDNAJB11.84852.0689204799_atZBED41.62692.0675238633_atEPC11.69992.0655238180_atSMU11.63512.0634201945_s_atBHLHB21.71682.0625209345_s_atPI4KII1.51472.0621239494_atLOC646725///LOC6494311.63682.0608238455_at-1.62642.0598201341_atENC11.90722.0536236196_at-1.50682.042920066_s_atDNAJB11.68742.097212374_atFEMIB1.69982.038120239_atKLHL71.59732.037221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.034323708_atPDE4B2.05922.034222551_s_atLOC440309//LOC6499081.59412.03242255_atWDR371.27232.025820564_atSERAC11.33652.0106157039_atSRAC11.33652.0106157039_atXRN11.43042.005320571_s_atXRN11.43042.005920176_atSERAC11.36742.021615098_d_atSCRA11.36742.021615098_d_atSCRA11.36552.0106157039_at <td>213537_at</td> <td>HLA-DPA1</td> <td>1.6066</td> <td>2.0813</td>	213537_at	HLA-DPA1	1.6066	2.0813
226390_at STARD4 1.5828 2.0764 227577_at EXOC8 1.6527 2.0717 200664_s_at DNAJB1 1.8485 2.0689 204799_at ZBED4 1.6269 2.0675 238633_at EPC1 1.6999 2.0653 221767_at BHLHB2 1.7168 2.0625 20345_s_at Pl4KII 1.5147 2.0621 239494_at LOC646725///LOC649431 1.6368 2.0608 201341_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0513 201341_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0513 20466_s_at DNAJB1 1.6874 2.0397 212374_at FEMIB 1.6998 2.0341 20239_at KLHL7 1.5973 2.0359 23598_at RAD23B 1.6276 2.0342 20378_at PDE4B 2.0592 2.0342 21763_at JMJDIC 1.3942 2.0265 242255_at WDR37	224663_s_at	CFL2	2.0207	2.081
$\begin{array}{llllllllllllllllllllllllllllllllllll$	226390_at	STARD4	1.5828	2.0764
20064_s_at DNAJB1 1.8485 2.0689 204799_at ZBED4 1.6269 2.0675 238633_at EPC1 1.6351 2.0634 201169_s_at BHLHB2 1.7168 2.0625 20345_s_at DI4KII 1.5147 2.0621 20345_s_at DI4KII 1.5147 2.0621 20344_at LOC646725///LOC649431 1.6368 2.0608 238435_at - 1.6264 2.0598 20131_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0516 20666_s_at DNAJB1 1.6874 2.0397 20239_at KLHL7 1.5973 2.0372 221768_at SFPQ 1.5509 2.0381 23598_at RAD23B 1.6276 2.0343 2078_at PDE4B 2.0592 2.0342 225951_s_at LOC440309///LOC649908 1.5941 2.0429 225951_s_at LOX40309//LOC649908 1.5941 2.0241 <tr< td=""><td>227577_at</td><td>EXOC8</td><td>1.6527</td><td>2.0717</td></tr<>	227577_at	EXOC8	1.6527	2.0717
$\begin{array}{llllllllllllllllllllllllllllllllllll$	200664_s_at	DNAJB1	1.8485	2.0689
238633_atEPC11.69992.0655228180_atSMU11.63512.0635228180_atBHL.HB21.71682.0625209345_s_atPI4KII1.51472.0621239494_atLOC646725///LOC6494311.63682.0608238455_at—1.62642.0593201341_atENC11.90722.0533204370_atHEAB1.70272.0516236196_at—1.50682.0429200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.038120239_atKLHL71.59732.0372221768_atSFPQ1.55092.035923598_atRAD23B1.62762.0342225951_s_atLOC440309///LOC6499081.59412.0424221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.499921207_atXIF1890.57910.499921207_atXIF1890.57910.499921207_atXIF1890.57910.4969	204799_at	ZBED4	1.6269	2.0675
228180_atSMU11.63512.0634201169_s_atBHLHB21.71682.0625209345_s_atPI4KII1.51472.0621209344_atLOC646725///LOC6494311.63682.0608238455_at-1.62642.0598201341_atENC11.90722.0533204370_atHEAB1.70272.0516236196_at-1.50682.0429200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.038120239_atKLHL71.55732.037221768_atSFPQ1.55092.0342223598_atRAD23B1.62762.034320370&atI.OC440309///LOC6499081.59412.0342225951_s_atLOC440309//LOC6499081.59412.0258205681_atBCL2A11.36742.0211569864_atSERAC11.33652.01061570394_atXRN11.43042.005321240_atXRN11.43042.005320751_s_atZNF1890.57910.499921240_atXRN11.43042.005320751_s_atZNF1890.57910.499921240_atXRN11.43042.005320751_s_atZNF1890.57910.499921240_atKIAA08590.57910.49962040_continued0.62410.496920541_continued0.49690.62412040_continued0.62410.496920541_continued <td>238633_at</td> <td>EPC1</td> <td>1.6999</td> <td>2.0655</td>	238633_at	EPC1	1.6999	2.0655
$\begin{array}{llllllllllllllllllllllllllllllllllll$	228180_at	SMU1	1.6351	2.0634
209345_s_atPI4KII1.51472.0621239494_atLOC646725///LOC6494311.63682.0608238455_at1.62642.0598201341_atENC11.90722.0533204370_atHEAB1.70272.0516236196_at1.50682.0429200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.0381220239_atKLHL71.59732.0372221768_atSFPQ1.55092.0382223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969(continued)0.62410.4969	201169_s_at	BHLHB2	1.7168	2.0625
239494_at LOC646725///LOC649431 1.6368 2.0608 238455_at - 1.6264 2.0598 201341_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0516 236196_at - 1.5068 2.0429 200666_s_at DNAJB1 1.6874 2.0397 212374_at FEM1B 1.6998 2.0381 220239_at KLHL7 1.5773 2.0372 221768_at SFPQ 1.5509 2.0342 203708_at PDE4B 2.0592 2.0342 225951_s_at LOC440309///LOC649908 1.5941 2.0342 221763_at JMJD1C 1.3942 2.0258 22555_at WDR37 1.2723 2.0258 205681_at BCL2A1 1.3674 2.0221 1569864_at SERAC1 1.3365 2.0106 157034_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.5791 0.4969 (contrinued) .00791 0.4969	209345_s_at	PI4KII	1.5147	2.0621
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	239494_at	LOC646725///LOC649431	1.6368	2.0608
201341_at ENC1 1.9072 2.0533 204370_at HEAB 1.7027 2.0516 236196_at - 1.5068 2.0429 200666_s_at DNAJB1 1.6874 2.0397 212374_at FEM1B 1.6874 2.0381 20209_at KLHL7 1.5973 2.0372 21768_at SFPQ 1.5509 2.0382 203708_at PDE4B 2.0592 2.0342 225951_s_at LOC440309///LOC649908 1.5941 2.0322 221763_at JMJD1C 1.3942 2.0258 242255_at WDR37 1.2723 2.0258 205681_at SERAC1 1.3674 2.0221 156964_at SERAC1 1.3365 2.0106 1570394_at XRN1 1.4304 2.0053 207513_s_at ZNF189 0.5791 0.4969 212407_at KIAA0859 0.6241 0.4969	238455_at	_	1.6264	2.0598
204370_atHEAB1.70272.0516236196_at1.50682.0429200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.038120239_atKLHL71.59732.0372221768_atSFPQ1.55092.0359203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.034221763_atJMJD1C1.39422.0265242255_atWDR371.27232.025820561_atBCL2A11.36742.0221156964_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969(continued)	201341_at	ENC1	1.9072	2.0533
236196_at—1.50682.0429200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.038120239_atKLHL71.59732.0372221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.025820581_atBCL2A11.36742.0221156964_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969(continued)	204370_at	HEAB	1.7027	2.0516
200666_s_atDNAJB11.68742.0397212374_atFEM1B1.69982.038120239_atKLHL71.59732.0372221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	236196_at	_	1.5068	2.0429
212374_atFEM1B1.69982.0381220239_atKLHL71.59732.0372221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	200666_s_at	DNAJB1	1.6874	2.0397
220239_atKLHL71.59732.0372221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	212374_at	FEM1B	1.6998	2.0381
221768_atSFPQ1.55092.0359223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	220239_at	KLHL7	1.5973	2.0372
223598_atRAD23B1.62762.0343203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	221768_at	SFPQ	1.5509	2.0359
203708_atPDE4B2.05922.0342225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	223598_at	RAD23B	1.6276	2.0343
225951_s_atLOC440309///LOC6499081.59412.0342221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	203708 at	PDE4B	2.0592	2.0342
221763_atJMJD1C1.39422.0265242255_atWDR371.27232.0258205681_atBCL2A11.36742.02211569864_atSERAC11.33652.01061570394_atXRN11.43042.0053207513_s_atZNF1890.57910.4999212407_atKIAA08590.62410.4969	225951_s_at	LOC440309///LOC649908	1.5941	2.0342
242255_at WDR37 1.2723 2.0258 205681_at BCL2A1 1.3674 2.0221 1569864_at SERAC1 1.3365 2.0106 1570394_at XRN1 1.4304 2.0053 207513_s_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.6241 0.4969	221763 at	IMID1C	1.3942	2.0265
205681_at BCL2A1 1.3674 2.0221 1569864_at SERAC1 1.3365 2.0106 1570394_at XRN1 1.4304 2.0053 207513_s_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.6241 0.4969	242255 at	WDR37	1.2723	2.0258
1569864_at SERAC1 1.3365 2.0106 1570394_at XRN1 1.4304 2.0053 207513_s_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.6241 0.4969	205681 at	BCL2A1	1.3674	2.0221
1570394_at XRN1 1.4304 2.0053 207513_s_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.6241 0.4969	1569864 at	SERAC1	1.3365	2.0106
207513_s_at ZNF189 0.5791 0.4999 212407_at KIAA0859 0.6241 0.4969	1570394_at	XRN1	1 4304	2 0053
212407_at KIAA0859 0.6241 0.4969 (continued)	207513 s at	ZNF189	0.5791	0 4999
(continued)	212407 at	KIA 40859	0.6241	0.4969
			0.0=11	(continued)

Appendix.	(Continued))
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Probe ID ^a	Gene symbol	Fold change ^b	
		2 h/0 h ^c	$4 h/0 h^{\rm d}$
218805_at	GIMAP5	0.6386	0.4966
223404_s_at	C1orf25	0.5826	0.4961
208893 s at	DUSP6	0.5503	0.4955
1552316 a at	GIMAP1	0.5609	0.4949
218979 at	RMI1	0.5514	0.4947
207907 ^{at}	TNFSF14	0.6168	0.4946
208891 at	DUSP6	0.4888	0.4937
238907 at	LOC284323	0.6243	0.4922
230226 s at	IARID1A	0.6606	0.4913
220235 s at	Clorf103	0.5597	0.488
228920 at	ZNF260	0.5932	0.4869
231576 at	ETNK1	0.7761	0.4838
221081 s at	DENND2D	0.6306	0.4826
219777 at	GIMAP6	0.5575	0.48
223583 at	TNFAIP8L2	0.5994	0.4747
209828 s at	П.16	0.6659	0.4737
206206 at	CD180	0.6085	0.4686
226230 at	SMEK2	0.618	0.4657
228190 at	CTR9	0.5411	0.4623
226481 at	VPRBP	0.5429	0.4613
235085 at	DKFZp761P0423	0.5794	0.4582
226977 at	LOC492311	0.6134	0.4544
216379 x at	CD24	0.5512	0.4533
223751 x at	TLR10	0.6385	0.4482
220992 s at	Clorf25	0.5581	0.4437
224953 at	YIPE5	0.5	0.4376
219243 at	GIMAP4	0.5749	0.4371
218242 s at	SUV420H1	0.5972	0.4344
227335 at	DIDO1	0.5739	0.4299
229367 s at	GIMAP6	0.5808	0.427
226423 at	PAOR8	0.5985	0.4188
200799 at	HSPA1A	0.617	0.4116
206978 at	CCR2	0.5425	0.408
227626 at	PAOR8	0.5885	0.4058
240646 at	GIMAP8	0.5375	0.4037
206991 s at	CCR5///LOC653725	0.5257	0.3864
226041 at	NAPE-PLD	0.5368	0.3817
207794 at	CCR2	0.6309	0.3811
205898 at	CX3CR1	0.5622	0.3734
222566 at	SUV420H1	0.4814	0.3719
233461 x at	ZNF226	0.5794	0.3675
200800 s at	HSPA1A ///HSPA1B	0.6225	0.3664
235306 at	GIMAP8	0.4554	0.3547
230337_at	SOS1	0.3715	0.344

^aAffymetrix U133 Plus 2.0 GeneChip[®] probe set IDs and annotations. ^bFold change as ratio of geometric means. ^cExpression at 2h/expression at 0h. ^dExpression at 4h/expression at 0h.