Detection and replication of epistasis influencing transcription in humans

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Abstract

Epistasis is the phenomenon whereby one polymorphism's effect on a trait depends on other polymorphisms present in the genome. The extent to which epistasis influences complex traits¹ and contributes to their variation^{2,3} is a fundamental question in evolution and human genetics. Though epistasis has been demonstrated in artificial gene manipulation studies in model organisms, 4,5 and some examples have been reported in other species,⁶ few convincing examples exist for epistasis amongst natural polymorphisms in human traits.^{7,8} Its absence from empirical findings may simply be due to its low incidence in the genetic control of complex traits,^{2,3} but an alternative view is that it has previously been too technically challenging to detect due to statistical power and computational issues.⁹ Here we show that, using advanced computation techniques¹⁰ and a gene expression study design, many instances of epistasis are found between common single nucleotide polymorphisms (SNPs). In a cohort of 846 individuals with data on 7339 gene expression levels in peripheral blood, we found 501 significant pairwise epistatic interactions between common SNPs acting on the expression levels of 238 genes $(p < 2.91 \times 10^{-16})$. We tested the discovery interactions for replication in two independent data sets. 11,12 Three hundred and forty-five interactions had replication interaction p-values that were more extreme than the 2.5% confidence interval of the distribution under the null hypothesis of no epistasis, with 30 significant at a conservative p < 0.05 Bonferroni level. There was evidence of functional enrichment for the interacting SNPs, for instance 44 of the genetic interactions are located within 2Mb of regions of known intra-cellular chromosome interactions¹³ ($p = 1.8 \times 10^{-10}$). Epistatic networks of three SNPs or more influence the expression levels of 129 genes, whereby one cis-acting SNP is modulated by several transacting SNPs. For example MBNL1 is influenced by an additive effect at rs13069559 which itself is masked by trans-SNPs on 14 different chromosomes, with nearly identical genotype-phenotype (GP) maps for each cis-trans interaction. This study presents the first evidence for multiple instances of epistatic genetic effects emerging from natural genetic variation in humans.

Main text

In the genetic analysis of complex traits it is usual for SNP effects to be estimated using an additive model where they are assumed to contribute independently and cumulatively to the mean of a trait. This framework has been successful in identifying thousands of associations, ¹⁴ but to date there is little empirical exploration of the role that epistasis plays in the architecture of complex traits in humans, ^{7,8} though its contribution to phenotypic variance is frequently the subject of debate. ^{1–3} Outside the prism of human association studies there is evidence for epistasis, not only at the molecular scale from artificially induced mutations ⁴ but also at the evolutionary scale in fitness adaptation ¹⁵ and speciation. ¹⁶

Methods are now available to overcome the computational problems involved in searching for epistasis, but its detection still remains problematic due to reduced statistical power. For example increased dependence on linkage disequilibrium (LD) between causal SNPs and observed SNPs, ^{17,18} increased model complexity in fitting interaction terms, ¹⁹ and more extreme significance thresholds to account for increased multiple testing⁹ all make it more difficult to detect epistasis in comparison to additive effects. Thus, when combined with small genetic effect sizes, as is expected in most complex traits of interest, ¹⁴ the power to detect epistasis diminishes rapidly. There are two simple ways to overcome this problem. One is by using extremely large sample sizes;²⁰ another is by analysing traits that are likely to have large effect sizes among common variants. Because our focus was to ascertain the extent to which instances of epistasis occur amongst natural genetic variation we designed a study around the latter approach and searched for epistatic genetic effects that influence gene expression levels. Transcription levels can be measured for thousands of genes. These traits are largely heritable but on average less polygenic than high level phenotypes,²¹ thus many genetic effects are relatively large, maximising the chance at detecting epistasis, should it exist.

In our discovery dataset (Brisbane Systems Genetics Study, BSGS²²) of 846 individuals genotyped at 528,509 SNPs, we exhaustively tested every pair of SNPs for genetic interactions against each of 7339 expression traits in peripheral blood. After stringent filtering and multiple testing correction (Methods) we identified 501 putative genetic interactions influencing the expression levels of 238 genes (Supplementary Table 4). Of the 501 discovery interactions, 434 had available data and passed filtering (Methods) in two independent replication datasets, Fehrmann¹² and the Estonian Genomics Centre University of Tartu (EGCUT),¹¹ in which we saw convincing evidence for replication. We used the summary statistics from the replication datasets to perform a meta analysis to obtain an independent p-value for the putative interactions, and 30 were significant after applying a Bonferroni correction for multiple testing (Table 1). These significant interactions exhibited remarkable similarity in GP maps between all three datasets (Figure 2).

In addition, using the meta analysis from the replication samples only, we observed that 316 of the remaining 404 discovery SNPs had replication interaction p-values more extreme than the 2.5% confidence interval of the distribution under the null distribution of no epistatic effects ($p << 1.0 \times 10^{-16}$, Figure 3 and Supplementary Figure S1). The congruence of the epistatic networks in discovery and replication datasets is shown in Figure 1, demonstrating that these complex genetic patterns are common even across independent datasets. A further replication was attempted using the Centre for Health Discovery and Wellbeing (CHDWB) dataset, ²³ but only 27 of the SNP pairs passed filtering because the sample size was small (n = 139), and likely due to insufficient power we found no evidence for replication. It should be noted that although it is a necessary step to establish the veracity of the signals from the discovery set, replication of epistasis is difficult in practice because the dependence on LD between observed SNPs and causal variants is up to three orders of magnitude

higher than it is for independent additive effects.^{17,18} Therefore these results are encouraging with regards to the detection and replication of epistasis.

Though seldom the focus of association studies, SNPs with known main effects are often tested for additive \times additive genetic interactions, ⁹ but our analysis shows that this is unlikely to be the most effective strategy for its detection. The majority of our discovery interactions comprised of one SNP that was significantly associated with the gene expression level in the discovery dataset, and one SNP that had no previous association²¹ (439 out of 501, Methods). Only nine interactions were between SNPs that both had known main effects while 64 were between SNPs that had no known main effects. Additionally, we observed that the largest epistatic variance component for the 501 interactions was equally divided amongst additive \times additive, additive \times dominance, dominance \times additive and dominance \times dominance at the discovery stage (p=0.22 for departure from expectation). This is not surprising because the patterns of epistasis used for statistical decomposition are not designed to resemble biological function.²⁴

Of the discovery interactions, 47 were cis-cis acting (both SNPs were on the same chromosome as the expression gene), 441 were *cis-trans*-acting, and 13 were trans-trans-acting. We observed a wide range of significant GP maps (Figure 2) but the most common pattern of epistasis that we detected involved a trans-SNP masking the effect of an additive cis-SNP. For example, MBNL1 (involved in RNA modification and regulation of splicing²⁵) has a *cis* effect at rs13069559 which in turn is controlled by 13 trans-SNPs and one cis-SNP that each exhibit a masking pattern, such that when the trans-SNP is homozygous for the masking allele the decreasing allele of the cis-SNP no longer has an effect (Supplementary Figure S5. Each of these interactions have evidence for replication in at least one dataset and six are significant at the Bonferroni level (Supplementary Figure S2). We see similar epistatic networks involving multiple (eight or more) trans-acting SNPs for other gene expresson levels too, for example TMEM149 (Supplementary Figure S6), NAPRT1 (Supplementary Figure S7), TRAPPC5 (Supplementary Figure S8), and CAST (Supplementary Figure S9). We observed that from pedigree analysis these five gene expression phenotypes had non-additive variance component estimates within the 95th percentile of the 17,994 gene expression phenotypes that were analysed previously²¹ (Supplementary Table S2, Methods).

In total the 501 interactions comprised 781 unique SNPs, which we analysed for functional enrichment (Methods). We tested the SNPs for cell-type specific overlap with transcriptionally active chromatin regions, tagged by histone-3-lysine-4,3-methylation (H3K4me3) chromatin marks, in 34 cell types²⁶ (Supplementary Figure S4). There was significant enrichment for cis-acting SNPs in haematopoietic cell types only ($p < 1 \times 10^{-4}$ for the three tissues with the strongest enrichment after adjusting for multiple testing). However trans-acting SNPs did not show any tissue specific enrichment (p > 0.1 for all tissues). This difference between cis and trans SNPs suggests different roles in epistatic interactions where the cis-SNPs provide tissue specificity in these interactions. There is also strong enrichment for SNPs to be localised in enhancer regions, ²⁷

consistent for both *cis* and *trans* SNPs $(p < 1 \times 10^{-6})$.

We also demonstrate spacial organisation of interacting loci suggesting a mechanism by which biological function can lead to epistatic genetic variance. It has been shown that different chromosomal regions spatially colocalise in the cell through chromatin interactions. We cross-referenced our epistatic SNPs with a map of chromosome interacting regions (n=96,139) in K562 blood cell lines (Methods) and found that 44 epistatic interactions mapped to within 2Mb ($p<1.8\times10^{-10}$), (Supplementary Figure S10). Interaction of distant loci may occur through physical proximity in transcriptional factories that organise across different chromosome regions and can regulate transcription of related genes. ^{29,30}

Though we present many instances of epistasis, quantifying its relative importance to complex traits in humans remains an open question. In this study we are able to identify 238 gene expression traits with at least one significant interaction given our experiment-wide threshold. How does this compare to the number of traits influenced by additive effects? The BSGS dataset has been previously analysed for additive effects at all expression traits, 22 and if we take all the additive eQTLs that were significant at the epistatic threshold of $p < 2.91 \times 10^{-16}$ we find that 453 gene expression levels out of the 7339 analysed had at least one significant expression quantitative trait locus (eQTL). Therefore it can be argued that the number of instances of detectable epistasis are substantial.

However in terms of their contribution to complex traits a more important metric might be the proportion of the variance that the epistatic loci explain.² Ideally one would approach this question from a whole genome perspective³¹ but this is intractable for non-additive variance components. Nevertheless, some inference can be made from the ascertained effects in these analyses and it is evident that additive variance is overall a larger component than epistatic variance, as has been argued previously.^{2,3} Taking the additive effects detected in Powell et al (2012) at the $p < 2.91 \times 10^{-16}$ threshold, we calculate that on average they explain 1.73% of the phenotypic variance of each of the 7339 probes. By contrast, the epistatic variance from the interacting SNPs detected in this study on average explain 0.25\% of phenotypic variance, approximately seven times lower than the additive variance. If we use the effect estimates taken from the Fehrmann or EGCUT datasets to perform the same comparison we obtain ratios of additive to epistatic variance of 36:1 and 34:1, respectively (Supplementary Figure S12, Methods). There are several caveats to this comparison. Firstly, the ratio of additive to epistatic variance may differ at different effect sizes, and our estimate is determined by the threshold used. Secondly, the power of a 1 d.f. test exceeds that of an 8 d.f. test. And thirdly, the non-additive variance at causal variants is expected to be underestimated by observed SNPs in comparison to estimates for additive variance, due to differences in the rate of decay of the estimate of the genetic variance of the causal SNPs as LD decreases with the observed SNPs.

Overall, we have demonstrated that it is possible to identify and replicate epistasis in complex traits amongst common human variants, despite the rela-

tive contribution of pairwise epistasis to phenotypic variation being small. The bioinformatic analysis of the significant epistatic loci suggests that there are a large number of possible mechanisms that can lead to non-additive genetic variation. Further research into such epistatic effects may provide a useful framework to understanding molecular mechanisms and complex trait variation in greater detail. With computational techniques and data now widely available the search for epistasis in larger datasets for traits of broader interest is warranted.

Methods Summary

We searched for pairwise epistasis exhaustively in the BSGS discovery dataset, ²² which comprises 846 individuals who are genotyped at 528,509 autosomal SNPs and who have gene expression levels measured in peripheral blood samples for 7,339 probes representing 6,158 RefSeq genes. Recent hardware and software 10 advances that use graphics processing units (GPUs) made it possible to perform the 1.03×10^{15} statistical tests to complete this analysis. We used permutation analysis³² to calculate an experiment-wide significance threshold of $T_e = 2.91 \times$ 10^{-16} at the 5% family-wise error rate (FWER). SNP pairs were modelled for full genetic effects, including marginal additive and dominance at both SNPs plus four interaction terms. Though we could have used a less complex model to improve statistical efficiency, we deemed it important to be agnostic about the type of epistasis that might exist, and therefore chose not to over-parameterise the test. ^{18,19} Because there are many large marginal effects present in these data it was necessary to perform several filtering steps to exclude SNP pairs that were significant due to marginal effects alone. All SNP pairs with LD $r^2 > 0.1$ and $D'^2 > 0.1$ were removed to minimise the possibility of haplotype effects. All SNP pairs were required to have at least five data points in all nine genotype classes. If multiple SNP pairs were present on the same chromosomes for a particular expression trait then only the sentinal SNP pair was retained. Finally, a nested test contrasting the full genetic model against the marginal additive and dominance model was performed for each remaining SNP pair (Methods), resulting in 501 significant interactions after Bonferroni correction for multiple testing of the filtered SNPs. The significant SNP pairs were carried forward for replication in two independent datasets that used the same expression assays for analysing transcription in peripheral blood, the Fehrmann dataset (n = 1)1240) and the Estonian Genome Centre University of the University of Tartu (EGCUT) dataset¹¹ (n = 891). Of these, 434 passed filtering in both replication datasets. A meta analysis on the interaction p-values from each replication dataset was performed to provide an overall replication statistic for each putative interaction.

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Tables 1

Table 1: Epistatic interactions significant at the Bonferroni level in two replication sets

	1	O					
	Gene (chr.)	SNP 1 (chr.)	SNP 2 (chr.)	BSGS^2	Fehrmann ³	$EGCUT^3$	Meta ⁴
1	ADK (10)	rs2395095 (10)	rs10824092 (10)	6.69^{1}	18.33^{1}	21.21^{1}	39.82^{1}
2	ATP13A1 (19)	rs4284750 (19)	rs873870 (19)	5.30	12.18	3.25	14.23
3	C21ORF57(21)	rs9978658 (21)	rs11701361 (21)	9.42	6.08	16.36	21.67
4	CSTB (21)	rs9979356 (21)	rs3761385 (21)	11.99	25.20	16.72	42.27
5	CTSC (11)	rs7930237 (11)	rs556895 (11)	7.16	18.76	15.06	33.53
6	FN3KRP (17)	rs898095 (17)	rs9892064 (17)	16.16	28.24	29.39	59.95
7	GAA (17)	rs11150847 (17)	rs12602462 (17)	13.91	19.98	12.99	32.60
8	HNRPH1(5)	rs6894268 (5)	rs4700810 (5)	15.38	8.55	3.01	10.37
9	LAX1(1)	rs1891432 (1)	rs10900520 (1)	19.16	18.60	11.22	29.24
10	MBNL1 (3)	rs16864367 (3)	rs13079208 (3)	13.49	16.25	24.74	41.56
11	MBNL1 (3)	rs7710738 (5)	rs13069559 (3)	7.92	2.55	7.89	9.28
12	MBNL1 (3)	rs2030926 (6)	rs13069559 (3)	7.10	0.91	5.80	5.53
13	MBNL1 (3)	rs2614467 (14)	rs13069559 (3)	5.74	4.13	2.22	5.30
14	MBNL1 (3)	rs218671 (17)	rs13069559 (3)	7.63	0.62	5.82	5.23
15	MBNL1 (3)	rs11981513 (7)	rs13069559 (3)	7.71	0.43	5.36	4.58
16	MBP (18)	rs8092433 (18)	rs4890876 (18)	5.40	7.06	21.91	28.73
17	NAPRT1 (8)	rs2123758 (8)	rs3889129 (8)	8.45	15.12	16.08	30.77
18	NCL (2)	rs7563453 (2)	rs4973397 (2)	7.31	7.51	6.33	12.70
19	PRMT2 (21)	rs2839372 (21)	rs11701058 (21)	4.81	0.69	4.47	4.06
20	RPL13 (16)	rs352935 (16)	rs2965817 (16)	4.98	3.79	14.41	17.24
21	SNORD14A (11)	rs2634462 (11)	rs6486334 (11)	7.31	13.11	10.96	23.22
22	TMEM149 (19)	rs807491 (19)	rs7254601 (19)	12.16	81.55	45.78	145.78
23	TMEM149 (19)	rs8106959 (19)	rs6926382 (6)	5.80	3.06	8.80	10.72
24	TMEM149 (19)	rs8106959 (19)	rs914940 (1)	6.22	3.36	6.96	9.20
25	TMEM149 (19)	rs8106959 (19)	rs2351458 (4)	7.30	0.04	9.61	8.00
26	TMEM149 (19)	rs8106959 (19)	rs6718480 (2)	8.55	3.31	5.15	7.36
27	TMEM149 (19)	rs8106959 (19)	rs1843357 (8)	6.21	3.72	3.33	6.00
28	TMEM149 (19)	rs8106959 (19)	rs9509428 (13)	9.44	0.10	5.75	4.47
29	TRA2A (7)	rs7776572 (7)	rs11770192 (7)	8.23	3.19	1.89	4.09
30	VASP (19)	rs1264226 (19)	rs2276470 (19)	5.09	0.94	5.14	4.95

 $^{^{1}}$ $-\log_{10} p$ -values for 4 d.f. interaction tests 2 Discovery dataset

 ³ Independent replication dataset
 ⁴ Meta analysis of interaction terms between replication datasets only

2 Figures

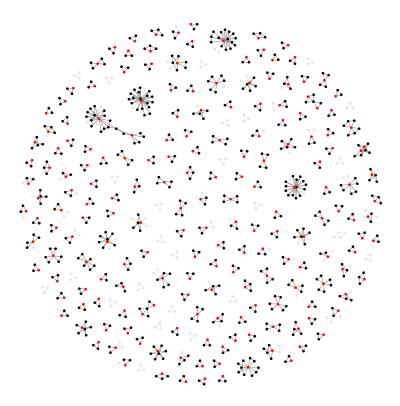


Figure 1: Discovery and replication of epistatic networks All 434 putative genetic interactions (edges) with data common to discovery and replication sets is shown, where black nodes represent SNPs and red nodes represent traits (gene expression probes). Three hundred and forty-five interactions had p-values exceeding the 2.5% confidence interval following meta analysis of the replication data, but the remaining 89 interactions that did not replicate are depicted in grey. It is evident that a large proportion of the complex networks identified in the discovery set also exist in independent populations.

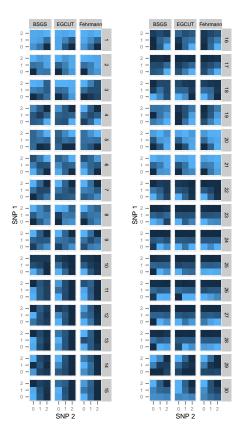


Figure 2: Replication of GP maps in two independent populations. The GP maps for each epistatic interaction that is significant at the Bonferroni level in both replication datasets are shown. Each GP map consists of nine tiles where each tile represents the expression level for that two-locus genotype class. Phenotypes are for gene transcript levels (dark coloured tiles = high expression, light coloured tiles = low expression). Columns of GP maps are for each independent population. Rows of GP maps are for each of 30 significantly replicated interactions at the Bonferroni level, corresponding to the rows in Table 1. There is a clear trend of the GP maps replicating across all three datasets.

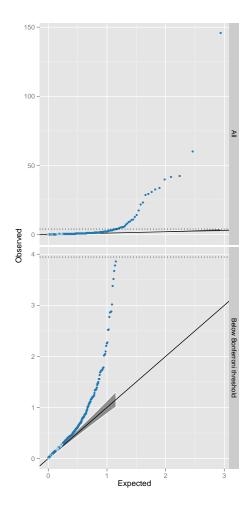


Figure 3: Q-Q plots of interaction p-values from replication datasets. The top panel shows all 434 discovery SNPs that were tested for interactions. Observed p-values (y-axis, $-\log_{10}$ scale) are plotted against the expected p-values (x-axis, $-\log_{10}$ scale). The multiple testing correction threshold for significance following Bonferroni correction is denoted by a dotted line. The bottom panel shows the same data as the top panel but excluding the 30 interactions that were significant at the Bonferroni level in the replication datasets. The shaded grey area represents the 5% confidence interval for the expected distribution of p-values. Dark blue points represent p-values that exceed the confidence interval, light blue are within the confidence interval.

3 Supplementary Figures

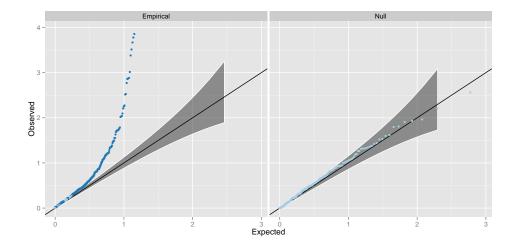


Figure S1: Q-Q plots of interaction p-values from replication datasets, excluding the 30 points significant at the Bonferroni level The right panel (Null) shows the interaction p-values from a meta analysis across two independent datasets on 434 randomly drawn SNP pairs. The left panel (Empirical) shows the interaction p-values from the 404 putative interactions that were not significant at the Bonferroni correction threshold. Dark blue points represent p-values that surpass the 2.5% FDR level, as in Figure 3.

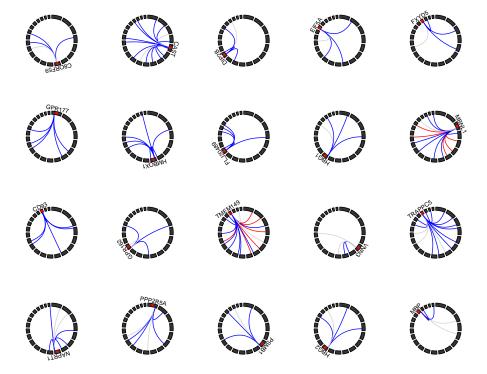


Figure S2: Gene expression traits with four or more genetic interactions Circle plots represent the genomic positions for SNPs (linking lines) and expression probes (red points). Chromosomes are represented by black blocks and ordered from 1 to 22 clockwise, starting from the top. Grey lines represent no evidence for replication, blue lines denote interactions that are outside the 97.5% confidence interval or the Q-Q plot (Figure 3), and red lines denote replication at the Bonferroni correction level. Most interactions are characterised as being *cis-trans* to the expression probe.

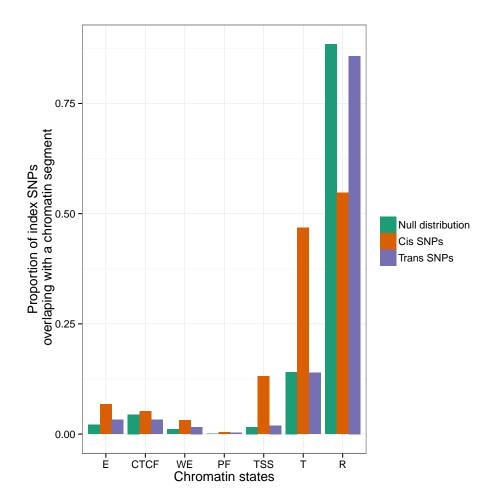


Figure S3: Location of SNPs relative to genomic features All SNPs within 1Mb and $r^2 > 0.8$ of each cis- and trans-SNP were taken to find which genomic features (x-axis) were covered by the SNPs that compose the 501 significant interactions. Green bars represent the proportion (y-axis) of the 528,509 SNPs used in the analysis that fall within the range of the different genomic features. There is enrichment for cis-acting SNPs (red bars) in promotor regions, but trans-acting SNPs (blue bars) are not enriched for genomic features. The labels on the x-axis are as follows: E = Predicted enhancer, CTCF = CTCF enriched element, WE = Predicted weak enhancer or open chromatin cis regulatory element, PF = Predicted promoter flanking region, TSS = Predicted promoter region including transcriptional start site, T = Predicted transcribed region, R = Predicted Repressed or Low Activity region

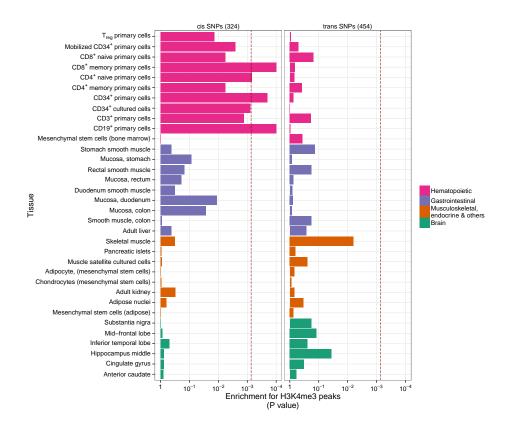


Figure S4: Tissue specific enrichment of SNPs in transcriptionally active regions The locations of transcriptional activity can be predicted by chromatin marks, assayed by H3K4me3. Enrichment p-values are calculated using permutation analysis for 34 different cell types (y-axis) in four tissue types (Rows of boxes). There is enrichment for cis-acting SNPs in Haematopoietic tissue types only. Trans-acting SNPs have no tissue specificity.

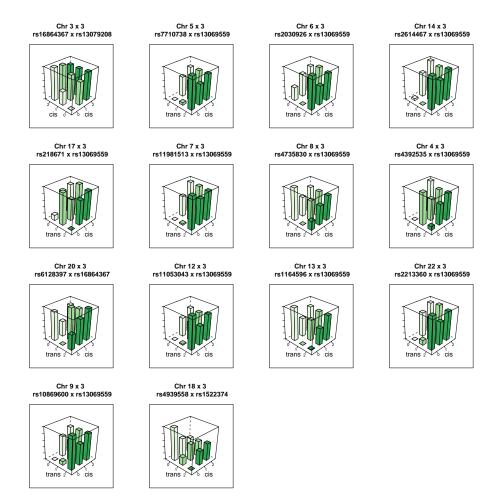


Figure S5: Genotype-phenotype maps for 14 interactions influencing the expression of MBNL1 Each bar represents the mean phenotypic value for individuals in that genotype class. The rs13069559 SNP typically has a *cis*-additive decreasing effect on the expression of MBNL1, but in many of these interactions the *cis* effect is masked when the *trans* SNP is homozygous.

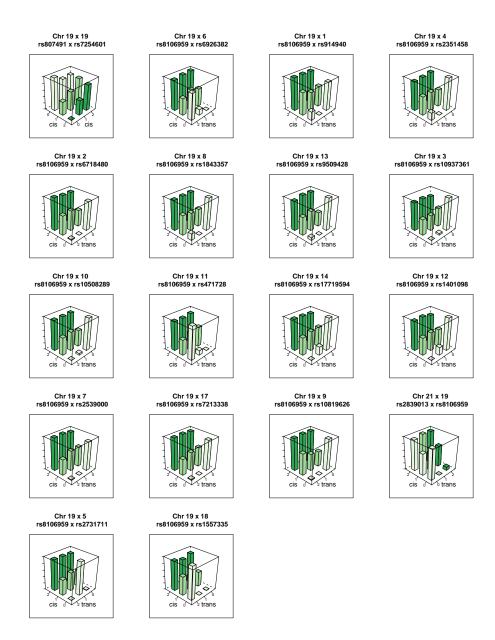


Figure S6: Genotype-phenotype maps for 19 interactions influencing the expression of TMEM149 Each bar represents the mean phenotypic value for individuals in that genotype class. The rs13069559 SNP typically has a *cis*-additive decreasing effect on the expression of TMEM149, but in many of these interactions the *cis* effect is masked when the *trans* SNP is homozygous.

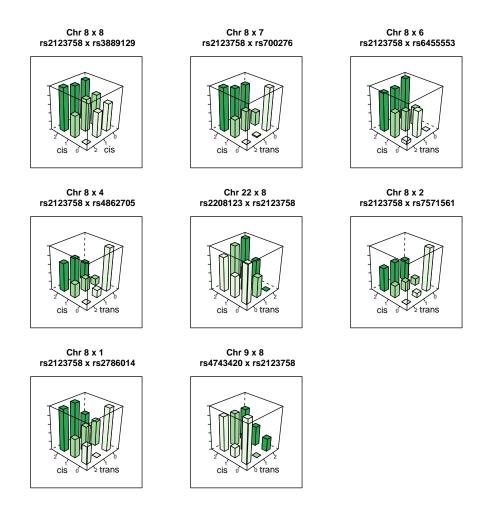


Figure S7: Genotype-phenotype maps for 8 interactions influencing the expression of NAPRT1 Each bar represents the mean phenotypic value for individuals in that genotype class.



Figure S8: Genotype-phenotype maps for 16 interactions influencing the expression of TRAPPC5 Each bar represents the mean phenotypic value for individuals in that genotype class.

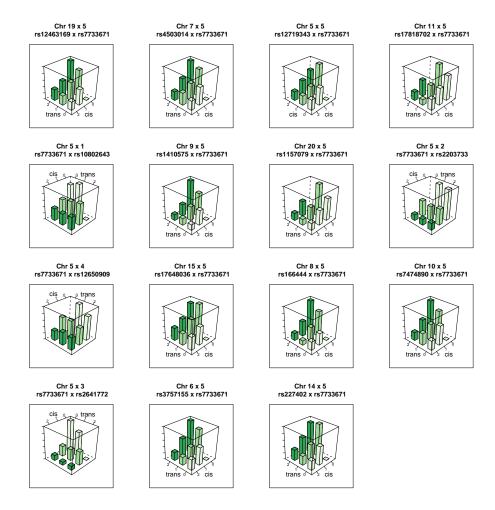


Figure S9: Genotype-phenotype maps for 15 interactions influencing the expression of CAST Each bar represents the mean phenotypic value for individuals in that genotype class.



Figure S10: Number of overlaps between chromosome interactions and epistatic interactions Interacting chromosome regions may be a possible mechanism underlying epistatic interactions. The number of epistatic interactions within 20kb, 500kb, 2Mb and 10Mb of known chromosome interacting regions are shown by red vertical lines. The histograms represent the null distribution based on random sampling of 10,000 datasets for each window size.

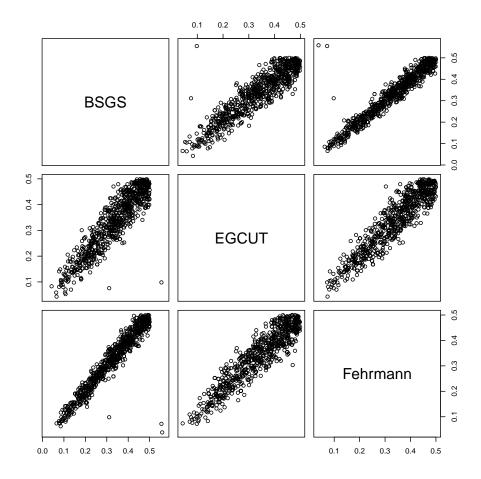


Figure S11: Comparison of allele frequencies for 781 SNPs involved in genetic interactions across independent populations Outliers were removed from the analysis as part of the filtering stage during replication.

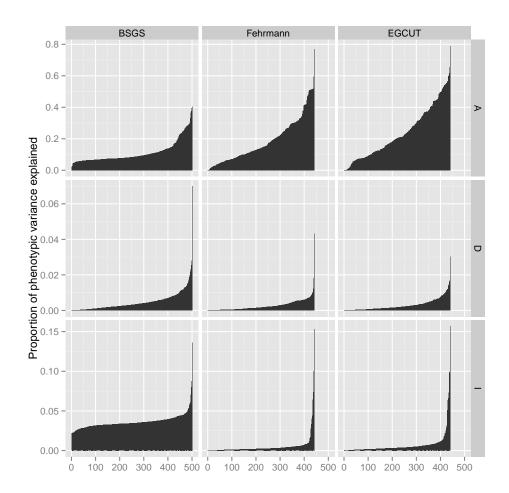


Figure S12: Comparison of variance explained by additive, dominant and epistatic effects from different cohorts How does the estimated variance decomposition change in different cohorts? The proportion of the phenotypic variance that is additive (A), dominant (D), or epistatic (I) for each putative interaction is shown on the y-axis (Note: different scales for each row). BSGS has 501 interactions whereas Fehrmann and EGCUT have 434 (x-axis). The variance estimates in each plot are ordered from lowest additive to highest. This is done independently for each cohort to depict the distribution of estimated effects.

4 Supplementary Tables

Table S1: Details on 501 interactions discovered in BSGS dataset

	Distance / Mb ^h						1	0.517			1 991	107.4								31.703						0.071							-											0.263				
values.	$Meta^g$	0.09 ^j		0.95	2.03	0.87	20.05	39.82	88	0.94	0.0	0.07	0.42	1.01	0.04	06.0	0.26		1.16							14.23	0.14	0.50	0.54	0.43	0.85	0.24	0.35						01.0	0.13	21.0	0.37	0.28	21.67	0.27	0.07		0.21
$/ - \log_{10} p$ -values	$EGCUT^{f}$	0.02^{1}		1.81	1.78	1.14	0.83	21.21	1 93	0.64	60.0	0.39	0.20	1.37	0.20	1.09	0.17		1.02							3.25	0.40	0.16	0.04	0.50	0.84	0.28	0.34						0 0	0.00	0.03	0.50	0.08	16.36	0.04	0.05	0	0.10
Interaction statistic	Fehrmann ^f	0.38^{1}		0.02	1.04	0.36	2.04	18.33	1.83	20.5	0.00	0.10	0.71	2.0	0.02	0.44	0.47	0.05	0.80							12.18	0.06	0.87	0.28	0.38	09.0	0.31	0.42						0 8 9	50.0	1000	0.29	0.65	80.9	0.72	0.29	0.31	0.00
Interact	$BSGS^{e}$	5.82	5.50	6.10	6.59	5.59	6.58	0.03	10.7	5.45	6.40	0.91 0.91	0.30	6.26	5.75	100	6.31	5.94	5.60	5.96	6.65	7.64	6.26	5.98	5.72	5.30	5.84	6.60	9.00	3.82	6.02	5.98	7.15	4.32	4.40	4.05	3.85	4.61	4.09	0.70	5.65	5.59	4.91	9.42	5.55	5.49	5.45	70.7
	Associationd						ADCKI			AHSA2	ALTID	ANTIL								ARL17B	ARL17B								C13OBF18		C14ORF173	C14ORF173							0170 D D60	CIOBES	C10RF86	C10RF86	ZNF641		C5ORF4	CSORF59	CSORF59	
SNP 2	Pos/Mb^{c}	158100199	139522101	136057883	72001517	122933691	78088813	05174310	61119471	61388355	E 2 4 8 0 7 0 E	195549900	1702045391	161996349	3032625	154511163	178019148	4818792	87918528	44064851	44064851	94722497	125831219	99492045	191203546	19738554	129906275	248059423	46913416	153610164	105189504	105189504	238724741	35427324	63371601	63179138	77574438	77574438	1.014438	9089566	2119833	2119833	48676038	47764477	154348552	86102223	86102223	02024200
,,	Chr.	9	6	-1	6	4 ;	4.0	J 7	0 6	10	1 0	1 0		r on) rC	-1	4	က	6	17	17	14	12	15	က	19	15		4 6	4	14	14	- :	4.	က	1	14	4.	4 1-	-		-	12	21	ro	oo (xo =	4
	rs ID	rs596183	rs914737	rs4732202	rs4744894	rs4833241	rs12431896	rs10824092	rs842647	rs1177303	2011211000 2012211000	rs13532400	rs1302032	rs11720112	rs4866516	rs3823523	rs6846031	rs4684443	rs2769594	rs8079215	rs8079215	rs1950646	rs2197777	rs2684789	rs9834627	rs873870	rs9804943	rs10888267	rs6555184	rs6857876	rs4983382	rs4983382	rs10754644	rs2655991 rs10972462	rs6445340	rs9787151	rs2655991	rs2655991	rs2055991	15/40003	rs2460002	rs2460002	rs901964	rs11701361	rs286595	rs2896452	rs2896452	rs1004564
	Associationd	ABCA7	ABCA7	ABCC3	ACAT1	ADCKI	70.4	ADK		HI.A.G		ALTTD	AKTID	ALDH3A2	ANG	ANPEP	ANPEP	AP3B1	APPL2			ARL17B	ARL17B	ARL17B	ARL17B		BID	1000	CIIORFI	C130RF18			C14ORF173														000	Cachros
NP 1	Pos/Mb^{c}	1047161	1047161	48771135	108207393	7808813	88462550	70440305	137112421	29938258	57701107	501121121 F9F9694E	52526245	19581009	21153299	90363995	90363995	77508159	105580918	75768225	35932619	44064851	44064851	44064851	44064851	19810050	18213057	18233000	6259852	46913416	37575398	92276674	105189504	77574438	77574438	77574438	70416307	51151724	62502622	110577957	46384412	25711358	48052838	48027084	45866512	36577930	31272238	80102223
S	Chr.	19	19	17	11	14	91	10	go	0 (0	9	16	16	17	14	15	15	ю	12	17	21	17	17	17	17	19	55	77.	119	13	22	15	14	0 4	14	14	17	7.5	1.3	- 9	18	16	21	21	18	13	20 0	0
	rs ID	rs3752237	rs3752237	rs9455	rs227064	rs12431896	rs8058066	rs2395095	rs10881585	rs2523971	2020201	rszosos40	rs/109019	rs3760489	rs9322855	rs11073891	rs11073891	rs6453374	rs935251	rs12947580	rs2834541	rs8079215	rs8079215	rs8079215	rs8079215	rs4284750	rs8919	rs181405	rs2508001 rs2110603	rs674754	rs11089825	rs3935344	rs4983382	rs1295455 rs2655991	rs2655991	rs2655991	rs4793445	rs6010061	rs/245800	159901091	rs2279474	rs7188668	rs4819271	rs9978658	rs1122762	rs12429804	rs12454561	F82690452
	Chr.	19	19	17	11	4.	4. 0	9 0	2,0	10	1 (4	16	16	17	14	12	15	ю	12	17	17	17	17	17	17	19	5 5 5	7.7	13	13	14	14	14	1 1	14	14	14	4.	1 4	-			21	21	ю	00 (x0 0	0
Expression trait	Probe ID ^b	ILMN_1743205	ILMN_1743205	ILMN_1677814	ILMN_1800008	ILMN-1698777	ILMN_1698777	ILMIN-2358626	M.M. 1798308	M.M. 1798308	II MN 1665080	ILMIN-1003962	ILMIN-1003962	ILMN 2401641	ILMN 1760727	ILMN_1763837	ILMN_1763837	ILMN_1768867	ILMN_1765076	ILMN_3231952	ILMN_3231952	ILMN_3231952	ILMN_3231952	ILMN_3231952	ILMN_3231952	ILMN_2134224	ILMN_1763386	ILMN-2372413	ILMIN-1/52988	ILMN 2196550	ILMN_2393450	ILMN_2393450	ILMN_2393450	ILMN_1804396	ILMN_1804396	ILMN_1804396	ILMN_1804396	ILMN-1804396	ILMIN_1804396	II.MN 1726989	ILMN_2097790	ILMN_2097790	ILMN_1795836	ILMN_1795836	ILMN_1728742	ILMN_1653205	ILMN_1653205	TEMIN-1003500
	Gene ID ^a	ABCA7	ABCA7	ABCC3	ACAT1	ADCK1	ADCKI	ACABA	AHSA2	AHSA2	ALTID	ANTIF	AKTID	ALDH3A2	ANG	ANPEP	ANPEP	AP3B1	APPL2	ARL17B	ARL17B	ARL17B	ARL17B	ARL17B	ARL17B	ATP13A1	BID	BID G110BE14	CHORFIA	C13ORF18	C14ORF173	C14ORF173	C140RF173	C14ORF4	C14ORF4	C14ORF4	C14ORF4	C140RF4	C14ORF4	CIOBES	C1ORF86	C10RF86	C21ORF57	C21ORF57	C5ORF4	CSORF59	CSORF59	CSORFOS

	Distance / Mbh							29.369																					14 697					100	1001												10000
alues	ಶ್ಚಿ	0.87	0.34		0.42	0.62	- C/-T	1.20	0.78	0.37	0.41	1.09	0.01	0.10	1.12	0.23	0.93	0.50	0.54	0.15	0.22	0.31	0.02	0.02	1.20	0.42	0.08	1.16	24.0				,	0.1I	0.48	1.44	0.12	0.09		0.44	0.36	0.67	0.73	0.03	1.39	0.01	Continued on next name
/ - log10 p-values	EGCUT	0.18	0.00		0.86	0.96	7.00	1.57	1.34	0.52	0.03	0.59	0.01	0 33	1.56	0.12	0.78	0.78	0.87	0.26	0.30	0.37	0.01	0.03	0.24	0.80	0.27	1.67	0.22	-			,	0.14	0.12	0.16	0.24	0.10		0.20	0.02	1.28	0.36	0.07	0.28	0.01	0.07
Interaction statistic	Fehrmannf	1.39	0.96		0.00	0.23	0.0	0.36	0.13	0.27	0.97	1.15	0.11	0.07	26.0	0.49	0.75	0.23	0.22	0.19	0.26	0.33	0.23	0.08	1.74	0.13	0.04	0.24	0.71					0.21	0.90	2.16	0.15	0.23		0.72	0.92	0.07	0.95	0.07	1.92	0.10	00:00
Interacti	BSGSe	5.79	6.36	5.81	6.61	7.07	7.00	7.68	6.55	7.01	7.81	6.62	6.12	0.07	# 00 1 00	6.74	7.42	7.42	6.07	6.93	6.41	80.0	5.62	5.09	90.9	5.71	5.56	6.31	7 .00 10 -10	7.43	7.02	6.13	80.9	5.46	6.15	6.67	5.75	6.36	5.65	5.74	4.75	0.00	7.54	7.56	6.33	6.34	9.74
	Associationd	C8ORF59	CABC1		INPP5E	CAST	CAST	CAST					CAT	CCDC88B	VAMP8	CD55					CD 93					CDCI6	CEACAM21			ANAPC13		CHPT1		CLECIZA	a E E	CFIP			CFVL								
SNP 2	Pos/Mb^{c}	86102223	227174210	82128660	139266496	96000269	96000269	96000269	96000269	96000269	96000269	96000269	96000269	96000269	96000269	96000269	238120177	170192890	224093101	195531841	34447586	64125142	85816334	207502534	157182040	7992632	196721395	125145394	23074375	238899903	136500554	74439542	77264482	115008038	42066556	158943044	180265266	134247706	235248562	102087844	81937002	10132283	134236688	63121080	67713633	61738094	29180410
	Chr.	∞ -			6	លេដ	ט גט	υ	ю	D.	ю	ı,	ı, ı	ņι) 10	ı.	1	4	7	က	11	11.	10	1	4	4	e ;	15	20	÷	œ	18	17	1 0	- 61	5	4	60	5	12	11	7.7	0 1	91	13	4 1	,
	rs ID	rs2896452	rs3738725	rs684040	rs4077515	rs7733671	rs//336/1	rs7733671	rs7733671	rs10802643	rs12650909	rs2203733	rs2641772	rs11032695	rs541207	rs1254900	rs6700168	rs10255470	rs4696726	rs7622580	rs838875	rs1884655	rs10925747	rs2873420	rs4328531	rs4789981	rs/324/44	rs4803481	rs2421050	rs13132719	rs13079012	rs772788	rs2695290	rs867578	rs7313235	rs3903088	rs169130	rs7336017	rs1455268	FSZ45884							
	Associationd	0000	Caoneria	INPP5E													CAST	CAST	CAST	CAST		ם פסט ברטט	CCDCSSB		CD93	CD93	CD93	CD93	CDS	CD93	CD93	CD93	CD93	00000	TOVE T	CEACAM21	CEP192		CES1					ABCA7	ABCA7		
SNP 1	Pos/Mb^{c}	7188323	4353908	139289825	6026661	6778978	81840122	125369113	78255630	78392770	27311111	86107920	70496867	126458593	31149140	59590078	96000269	96000269	96000269	96000269	66175386	17099980	80280117	76033374	23074375	23074375	23074375	23074375	37771578	23076914	23076914	23076914	23076914	104162263	51956250	42066556	13069782	101350298	55861794	38838122	102277782	84471642	10156646	1047161	1047161	145569535	20119902
01	Chr.	16	g [6	Ξ;	7.0	16	'n	6	œ	12	11	14	7 (9	40	10	70	rO	ю	ro .	00 0	61.	11	11	20	20	20	20	0.20	20	20	20	20	1.	20	19	18	14	16	13	175	16	7 -	51	19	œ ç	οŢ
	rs ID	rs8051751	rs12765847	rs4266763	rs4573661	rs1157079	rs12599264	rs12719343	rs1410575	rs166444	rs17648036	rs17818702	rs227402	182022124 183757155	rs4503014	rs7474890	rs7733671	rs7733671	rs7733671	rs7733671	rs872311	rs2353203	rs5211834	rs750801	rs1884655	rs1884655	rs1884655	rs1884655	rs2868504	rs4813479	rs4813479	rs4813479	rs4813479	rs861544	rs200609	rs4803481	rs6505780	rs3825569	rs8192935	rs591967	rs6539014	rs429790	rs7305054	rs3752237	rs3752237	rs4333645	rs12596791
	Chr.	oo o	n -	6	6	iO H	0 10	'n	ю	r	ю	ı,	ı, ı	O M) IC	ıo	10	ю	Ŋ	n	11	1:	11	П	20	20	50	50	0.00	200	20	20	50	13	61	19	18	e	16	12	12	7 7	2 1	9	13	ο I	,
Expression trait	Probe ID ^b	ILMN_1653205	ILMN 1731064	ILMN_1712532	ILMN_1712532	ILMN-1717234	ILMN-1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMIN-1717534	II.MN 1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1717234	ILMN_1651705	ILMIN_1772208	ILMN_1784863	ILMN_1800540	ILMN_1704730	ILMN_1704730	ILMN_1704730	ILMN_1704730	ILMN 1704730	ILMN-1704730	ILMN_1704730	ILMN_1704730	ILMN_1704730	ILMN_2339796	ILMN 1745949	ILMN_1745949	ILMN_1703754	ILMN_1787808	ILMN_2359945	ILMN-2202940	ILMN_2202940	ILMN-1663142	ILMN_2403228	ILMN 1770290	ILMN_1770290	ILMN_1654545	1LMIN_1682928
Exp	Gene IDa	CSORF59	Caone 12	CARD9	CARD9	CAST	CASI	CAST	CAST	CAST	CAST	CAST	CAST	CAT	CCDCSSB	CCDCSSB	CD55	CD93	CD93	CD93	CD93	CD93	CD93	CD93	CD93	CD93	CDCI6	CEACAM21	CEACAM21	CEP192	CEP63	CES1	CHPT1	CHPT1	CLECIZA	CLECIZA	CNN2	CNN2	CPSF1	CFVL							

	nce / Mb ^h			0.033			0.040						12.255																	66.920	0.052													-					10.736	10.10
	Distance																																																	
values	Metag	0.04	0.15	42.27	0.11	1.03	33.73	00.00	0.34	40.0	1.47	0.36	0.44	09.0	0.44	0.14	0.42	0.44	0.16	0.29	0.58	0.32	0.37	0.03	0.10		0.19		0.01	0.11	0.97	1.12	0.0	1 6	0.79	0.10	0.24	0.41	0.02	0.53	0.11	0.41		0.35	0.81	0.09	0.08	1.06	0.44	0.23
- log10 p-values	EGCUT	0.03	0.36	16.72	0.41	0.74	15.06	0.01	0.00	0.02	1.87	0.83	0.10	0.86	0.41	0.58	0.25	0.29	0.41	0.02	1.17	0.34	0.04	0.11	0.05	0.58	0.22		0.02	0.00	1.45	0.27	1.18 8 2 6 0	0.00	0.47	0.11	0.08	0.59	0.05	1.12	0.04	0.40		0.58	1.20	0.11	0.04	1.03	0.19	0.30
<u> </u>	Fehrmann ^f 1	0.19	0.10	25.20	0.02	0.92	18.76	10.0	0.23	0.20	0.39	0.05	0.87	0.29	0.48	0.00	0.64	0.61	80.0	0.77	90.0	0.37	0.88	0.05	0.32		0.30	0.37	0.09	0.48	0.23	NO.10	0.15	0.64	0.90	0.23	0.56	0.28	80.0	0.05	0.36	0.45		0.20	0.25	0.20	0.29	0.67	0.74	0.97
Interaction statistic	BSGS ^e Fel	5.55	6.18	11.99	5.74	5.67	7.16	5 43	1 0	89.50	5.81	5.53	5.85	5.42	5.44	9.12	5.62	5.31	5.47	6.39	00.9	6.48	5.51	7.64	4.65	4.87	5.31	4.40	5.03	5.92	5.79	0.17	4.81 6.10	0 10 0 00 0 00	86.98	5.56	5.44	5.55	6.36	5.52	6.51	5.56	6.03	5.70	5.43	6.11	5.65	5.63	6.83 6.83	0.01
	Associationd	CPVL			CTNNA1	CoEC	2010	CWF19T.1	CYBBD1	CYBED1	CYBRD1	CYBRD1		CYP27A1	DAB2					COQ10A	DHRS9	DHRS9	DHRS9	DHRS9	LASS5		LASS5		1	LASS5	DNAJB6	בחקם	SCHOOL	ECHDC2	EHD4	EIF2B2					EMR2	EMR2		EPHX2	ERICH1	ERICH1	ERICH1	0	EXOC3	FARIDI
SNP 2	Pos/Mb ^c	29188475 46843631	62406408	45198355	138226767	108679892	_	102027407	172368120		_	172368120	160112881	219650616	39381357	82076988	187475208	32451144	88204888	137810259	169960422	169960422	169893419	169893419	50610976	153134888	50730458	61971140	115214154	51074199	157163614	16320360	64004670 F24025F2	53402552	42192040	75590340	99603119	49359676	129624067	126387391	14879034	14879034	102480759	27400604	578742	607161	578742	182786760	1972548	
01	Chr.	٥ - ٦	ıv	21	20	10	: :	1 .	6	10	1 (2)	2	0	2	ю	9	8	6	7	6	2	7	7	7	12	7	12	œ	10	12	٠ ،	n 0	χ-		120	14	14	7	œ	11	19	19	13	œ	œ	oo i	œ ·	4,1	ر د م	0,7
	rs ID	rs245884	rs1473927	rs3761385	rs176382	rs7079264	rs556895	rs12784396	rs888427	rs888427	rs888427	rs888427	rs7591849	rs933994	rs835223	rs1343244	rs2378341	rs7042042	rs2519515	rs10120023	rs7566044	rs7566044	rs2161037	rs2161037	rs11169322	rs2872008	rs7134595	rs1808634	rs4532958	rs12427378	rs3779589	rs1500972	rs4891884	rs11206043	rs1048166	rs175450	rs1269096	rs1553474	rs2197210	rs4471434	rs9305048	rs9305048	rs3007765	rs13269963	rs12115088	rs4735900	rs12115088	rs1517297	rs12188164	rs344303
	Associationd		CRLS1		0	CISC							CYBRD1				DDT		COQ10A							LASS5		LASS5	LASS5			100	ECGFI				EIF5A	EIF5A	EIF5A	EIF5A			EMR2					ERICH1		
SNP 1	Pos/Mb^{c}	39202070 188859908	5986234	45230974	69500505	88139983	88117962	11456027	129994690	140698856	12318284	23344590	172368120	36571928	110451383	43111688	24248761	125962645	137810259	106703727	89468283	147132505	29959453	187776431	29161503	50636364	41711815	50730458	50744171	117994348	157216093	93409054	50971266	17675900	53244938	60218334	7221707	7221707	7221707	7221707	23196249	18761714	14879034	127909396	134611176	45337329	31187910	600729	55228462	12/102/00
ß	Chr.	21	20	21	18	11	7 -	: :	4	+ O	10	20	2	20	1-	17	22	11	6	11	12	7	21	4	17	12	19	12	12	15	<u>-</u>	o 6	77 0	1 0	5	18	17	17	17	17	21	20	19	11	11	55	18	œ ç	010	0 7
	rs ID	rs2835998 rs2131290	rs6139887	rs9979356	rs924943	rs2457684	rs7930237	rs7108734	rs2592948	rs7852475	rs11257679	rs6137908	rs888427	rs6021982	rs7778910	rs9900173	rs5760102	rs4937097	rs10120023	rs12363827	rs1519956	rs1528529	rs2831914	rs7661304	rs11080134	rs11169335	rs338585	rs7134595	rs7312252	rs871257	rs2286842	rs12232308	rs140522	rs5992637	rs10403312	rs6567288	rs7216490	rs7216490	rs7216490	rs7216490	rs2827076	rs6132112	rs9305048	rs1107764	rs10894861	rs5766218	rs726145	rs4735895	rs187076	rs1350104
	Chr.	٥ ٦	20	21	ro ;		1 :	1.0	6	10	1 01	. 61	. 61	71	ıO	17	22	6	1	1	73	67	67	67	12	12	12	12	12	12	- c	n (77		1 10	14	17	17	17	17	19	19	19	<u></u>	∞				٠ <u>۱</u>	91
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Exi	Gene ID ^a	CPVL	CRLS1	CSTB	CTNNA1	CISC	CEST	CWF191.1	CYBRD1	CYBRD1	CYBRD1	CYBRD1	CYBRD1	CYP27A1	DAB2	DCAKD	DDT	DDX58	DEM1	DEM1	DHRS9	DHRS9	DHRS9	DHRS9	DIP2B	DIP2B	DIP2B	DIP2B	DIP2B	DIP2B	DNAJB6	D7.55	ECGFI	ECHDCE FCHDC2	EHD4	EIF2B2	EIF5A	EIF5A	EIF5A	EIF5A	EMR2	EMR2	EMR2	EPHX2	ERICH1	ERICH1	ERICH1	ERICH1	EXOC3	FABDI

ationd 488 662 67 65 62 62 62 63	rs ID Chr. rs13406184 2 rs11691600 2	Pos/Mb ^c	Associationd	BSGS ^e Fehrmann	F EG	f Metag	Distance / Mb ^h
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1 rs12527241 6 124468039 1 rs12527241 6 124468039 1 rs12532999 7 12793793 1 rs12532999 7 127938793 1 rs12532999 7 127938793 1 rs25613 16 11160683 1 rs656669 18 70560011 1 rs2590426 3 717399321 1 rs1224677 7 38028634 CSDMB 1 rs124677 1 s194687 1 s194688 2 s3839979 1 rs139888 2 s3839979 1 rs139888 2 s3839979 1 rs139888 1 rs1398	rs9827054 3	188880113					
1 rs12527241 6 120468039 1 rs12532999 7 12793793 1 rs755613 16 1106683 1 rs756613 16 1106683 1 rs656669 18 71560018 1 rs1224467 13 8028634 1 rs1244574 17 8834833 1 rs1244574 13 8534457 1 rs1244574 13 8534457 1 rs124888 22 8339979 1 rs107883 17 4523167 1 rs1107883 17 4523167 1 rs124666 19 357367 1 rs125666 19 357367 1 rs125666 19 357367 1 rs125666 19 357367 1 rs125666 19 357367 1 rs1257666 19 357367 1 rs1257666 19 357367 1 rs1257666 19 357367 1 rs1257666 10 357367 1 rs1257678 10 3571671 rs1257678 10 rs125768 10 rs125768 10	rs12065581 1	68732819	GPR177				
1 rs42532999 7 12793793 1 rs9575613 11166683 1 rs9575097 13 82986268 1 rs6566669 18 77506011 1 rs9575047 17 38058263 17 rs9520426 3 771399321 17 rs1557467 17 38058634 GSDMB 18 rs1547574 13 8514527 1 1 rs1547574 13 8514527 1 22 rs138898 22 38399979 2 22 rs138888 22 38399979 2 22 rs138888 22 38399979 1 11 rs1078523 17 4523167 11 rs2855039 11 5271671 HBG2	rs12065581 1	68732819	GPR177		_		
1 rs972613 16 1166883 1 rs9775097 13 rs9586669 18 7506011 1 rs95966669 18 7506011 1 rs92900426 3 717399321 1 rs1254674 7 38028634 GSDMB 1 rs12547574 17 38028634 GSDMB 1 rs6492807 13 s916560 22 rs139808 22 rs139808 22 rs139808 22 rs139808 22 rs139808 22 rs139808 11 rs12076823 17 4523167 11 rs1297666 19 3573671 HBG2	065581 1	68732819	GPR177				
1 res9575097 13 82982288 1 res920426 13 70506011 1 res1257467 17 38028634 1 res1248673 10 58192833 1 res12446774 13 8534457 2 res138898 22 38399979 22 res138898 22 38399979 22 res189888 22 38399979 11 res1078523 17 4523167 11 res2850399 11 5771671 HBG2	rs12065581 1	68732819	GPR177				
1 rse5566669 18 70506011 1 rse9290426 3 71399321 1 rse11557467 17 38028634 1 rse11557467 17 38028634 1 rse1547574 13 85149580 2 rse642807 13 9615560 2 rse138898 22 38399979 2 rse139888 22 38399979 1 rse11078523 17 4523167 1 rse129666 19 35728501 1 rse2550399 11 5571671 HBG2	065581 1	68732819	GPR177				
1 rs92204245 3 171393321 GSDMB rs925204246 17 rs1255467 17 539028634 GSDMB rs12548673 10 55192833 GSDMB rs12548673 11 rs12548673 12 s3399979 22 rs139898 22 s3399979 22 rs139898 22 s3399979 11 rs12975066 19 35723501 rs28550399 11 rs28550399 11 rs28550399 11 rs2875066 19 3577671 HBG2	065581 1	68732819	GPR177				
17 rs11557467 17 38028634 GSDMB rs12248673 10 551928633 1 rs1547674 13 85344527 1 rs15402807 13 8534527 2 rs138888 22 83899979 22 rs138888 22 83839979 22 rs138888 22 83839979 11 rs12978653 17 4523167 rs2855039 11		68732819	GFRI				
1 rs1224574 10 53192833 1 rs16245774 13 56344527 22 rs139808 22 38399979 22 rs139808 22 38399979 11 rs1076823 17 4523167 11 rs1076823 17 4523167 11 rs255666 19 3573501	65745 15	101508261					
1 rslo47574 13 8534527 1 rslo492807 13 8534527 13 8534527 13 8534527 13 8534527 13 rslo3888 22 rslo3888 22 83399979 11 rslo75563 17 4523167 11 rslo566 19 35723501 11 rslo566 19 35774671 14 HBG2	101992 1	110266754	GSTM1				
1 re6422807 13 9615560 22 re138898 22 38399979 22 re138898 22 38399979 11 re11078523 17 4523167 11 re1297666 19 35725361 11 re2555639 11 5271671 HBG2	101992	110266754	GSTM1		0.27	0.79	
22 rs138898 22 38399979 22 rs139898 22 38399979 11 rs11078523 17 4523167 11 rs255066 19 35723501 11 rs285039 11 5271671 HBG2	54446 1	110253241	GSTM1				
22 rs139898 22 38399979 22 rs139888 12 38399979 11 rs12078523 17 4523167 11 rs2297566 19 35723501 11 rs2855039 11 5271671 HBG2		77919015					
22 rs138888 22 3839979 11 rs107853 17 4523167 11 rs2975066 19 35725501 11 rs2855039 11 5271671 HBG2		85877017					
11 rs1107823 17 4533167 11 rs12975066 19 35723501 11 rs2855039 11 5271671 HBG2	83949 21	19532546					
11 rs12975066 19 35723501 11 rs2855039 11 5271671 HBG2	55039 11	5271671	HBG2				
11 rs2855039 11 5271671 HBG2	rs2855039 11	5271671	HBG2				
	rs12042181 1	213088494	LQK1				
11 rs2855039 11 5271671 HBG2	rs12503379 4	141533832	000	6.42	0.01 0.46		
17 4523167	rs16912979 11	2309092	HBGZ		0.01 0.41		0.10

	Distance / Mb ^h										0	103.850			0.041														0.097																0.118				
																																																_	
-values	$Meta^g$	0.05	0.10		0.32	1.22	0.52	0.86	1.34	0.46	2.52	0.44	2.20	0.02	10.37					0.29	0.44	1.55	0.05	0.33	0.77	0.37	0.28	0.03	29.24		0.34	0.02	1	0.15	0.0	0.03	0.49	0.59	1.09		0.54	1.37	1.34	4.58	41.56	5.53	5.23	0.70	
- log10 p-values	$EGCUT^{f}$	0.13	0.46		0.59	0.34	0.16	0.47	1.11	1.01	3.13	0.34	0.03	0.00	20.80					0.50	0.23	0.84	0.26	0.13	0.89	0.80	0.08	0.0	11.22		0.40	0.03	0.13	0.35	0.15	0.03	0.36	0.88	1.11		0.27	2.21	0.63	5.36	24.74	5.80	5.82	0.72	
Interaction statistic /	$Fehrmann^{f}$	0.08	0.00		0.15	1.61	0.90	1.00	0.92	0.02	0.39	0.55	80.00	0.34	0 00 0 10 10 10					0.19	69.0	1.46	0.02	0.65	0.46	80.0	0.64	0.00	18.60		0.35	0.23	;	0.11	0.13	0.13	0.61	0.25	0.63	1.18	0.79	80.0	1.43	0.43	16.25	0.91	0.62	0.52	2.2
Interacti	BSGSe	5.77	5.98	5.75	5.98	5.81	5.94	5.69	6.54	6.62	5.80	6.58	88.0	6.12 7.45	25.25	5.51	6.51	6.61	6.48	06.9	5.53	5.58	8.16	5.64	4.74	5.53	5.45	7.00 7.00	19.16	6.00	5.16	6.13	5.89	5.68	0.01	0.90 71	6.31	5.62	5.93	5.78	2.96	6.70	7.38	7.71	13.49	7.10	7.63	6.05	
	Associationd	HBG2	T CAN T	HDAC7		HEXDC	HLA-DRB6	HLA-H	HMBOXI	HMBOXI	HMBOX1	HMBOX1		TWD OV1	TWO	HSPC157	HSPC157	HSPC157	HSPC157		IL32	INPP5E				KTELC1	KTELCI	LADS	LAFS	LDLRAP1			1	LRRC25		1.7.2			MAD2L1BP	MAP1LC3A	MBNL1	MBNL1	MBNL1	MBNL1		MBNL1	MBNL1	MBNL1	
SNP 2	$\mathrm{Pos/Mb}^{\mathrm{c}}$	5271671	141533832	48173352	135220622	80378939	32411646	29695713	28876221	28751381	28904086	28876221	189533772	158276926	178991794	22439520	22439520	22439520	22439520	131757163	3115628	139335599	28288174	5570771	189055298	119119433	119195913	17588050	203780591	25889632	179608360	71561497	127804531	18496107	18940879	69734641	130319560	127011798	43528441	33351864	152187431	152187431	152187431	152187431	152116652	152187431	152187431	152187431	
J)	Chr.	11	4	12	œ	17	9	9	x 0 (x	00 (x 0 0	n I	- 0) id		н	1	1	12	16	6	-	11	4 (n	n -		* -	-	Ю	18	10	19	1 -	- 61	10	n	9	20	8	8	ဂ	ဂ	ဂ	3	က	က	
	rs ID	rs2855039	rs12503379	rs4760636	rs17686635	rs7213057	rs7192	rs2523404	rs7837237	rs4732890	rs8180944	rs7837237	rs4553956	rs/810884	rs4700810	rs4654783	rs4654783	rs4654783	rs4654783	rs4759890	rs1554999	rs1127152	rs849341	rs424299	rs6419960	rs727905	rs6414283	re7658940	rs10900520	rs6687605	rs11749727	rs714789	rs1278387	rs8101804	rs1043075	rs11901/20	rs2253135	rs6414306	rs1096699	rs6060034	rs13069559	rs13069559	rs13069559	rs13069559	rs13079208	rs13069559	rs13069559	rs13069559	
	Associationd	000	HBG2		HEBP1								HMBOXI	HMBOAI					CWF19L1	IL32				KCNJ15	KIR2DL1		LOMBELO	DOMED LEA				LILRA5	LINS1	0071	17.20	717	LYZ	MAD1L1											
SNP 1	Pos/Mb^{c}	35723501	5271671	6036851	13145613	71237270	77532672	75467313	98670849	42112794	127237464	132725731	28904086	110807444	179032488	88882257	46486900	121229893	101884937	3115628	2560423	81603771	47970693	39606769	55324635	84597119	183109012	132602868	203877662	59971635	26083392	54827248	101120963	51151350	0000001	77276964	69734641	1923385	103203146	29435869	78225815	9932070	97100681	94648239	152234166	114067127	6604708	34291750	
J1	Chr.	19	: ::	16	12	18	14	x ;	14	21	12	x 0 (x 0 0	χç	, ro	16	20	12	10	16	19	16	12	21	19	13	4 6	4 0	n	121	17	19	12	22.0	٥	2 2	12	1	13	21	6	12	13	4	3	9	17	25	
	rs ID	rs12975066	rs2855039	rs2109029	rs3782567	rs1942719	rs4899635	rs11660982	rs12435486	rs2837803	rs4765451	rs587639	rs8180944	rs8180944	rs6894268	rs555812	rs6063164	rs662739	rs7088558	rs1554999	rs765044	rs8044524	rs757355	rs2186344	rs649216	rs4349034	rs6815953	re7042087	rs1891432	rs1552032	rs12450521	rs3859532	rs11247226	rs6009951	18977780	rs2100029	rs2168029	rs7783715	rs7983718	rs974607	rs10869600	rs11053043	rs1164596	rs11981513	rs16864367	rs2030926	rs218671	rs2213360	
	Chr.	11	11	12	12	17	9	9	x 0 (00	90 (x 0 0	x 0 0	x0 0) ic		н	-1	1	16	16	6	-1	21	19	n (n 6	4 4	* -		17	19	12	61	0 5	1 1 2	12	1	9	20	8	6	e	e	e	e	က	<u>ი</u>	
Expression trait	Probe ID ^b	ILMN_2084825	ILMN_2084825	ILMN_3266186	ILMN_1802557	ILMN_1741180	ILMN_2157441	ILMN_1762861	ILMN_1720059	ILMN-1720059	ILMN_1720059	ILMN_1720059	ILMN_1720059	ILMIN-1720059	II.MN 2101920	ILMN_3194087	ILMN_3194087	ILMN_3194087	ILMN_3194087	ILMN_1778010	ILMN_2368530	ILMN_1811301	ILMN_1682727	ILMN_1675756	ILMN_1691803	ILMN_1811104	ILMN_1811104	ILMN 1683709	II.MN 1769782	ILMN_1809040	ILMN_2412214	ILMN_2357419	ILMN_2338197	ILMN_2150196	ILMIN_1807825	ILMN 21629279	ILMN 2162972	ILMN_2358069	ILMN_1694711	ILMN_1776188	ILMN_2313158								
Exp	Gene ID ^a	HBG2	HBG2	HDAC7	HEBP1	HEXDC	HLA-DRA	HLA-F	HMBOXI	HMBOXI	HMBOX1	HMBOX1	HMBOXI	HMBOAI	HNRPH1	HSPC157	HSPC157	HSPC157	HSPC157	IL32	1L32	INPP5E	JAZF1	KCNJ15	KIR2DS5	KTELC1	KTELC1	LADS	LAXI	LDLRAP1	LGALS9	LILRA5	LINSI	LKRC25	LY 80	177	LYZ	MAD1L1	MAD2L1BP	MAP1LC3A	MBNL1								

Ex	Expression trait				SNP 1				SNP 2		Interac	Interaction statistic /	- log10 p-values	values	
Gene ID ^a	Probe ID ^b	Chr.	rs ID	Chr.	Pos/Mb ^c	Associationd	rs ID	Chr.	Pos/Mb ^c	Associationd	BSGSe	Fehrmann ^f	$EGCUT^{f}$	Metag	Distance / Mbh
MBNL1	ILMN_2313158	3	rs4392535	4	41513423		rs13069559	33	152187431	MBNL1	8.39	0.02	4.33	3.02	
MBNL1	ILMN_2313158	e	rs4735830	œ	895841		rs13069559	က	152187431	MBNL1	6.74	0.32	4.21	3.38	
MBNL1	ILMN_2313158	3	rs4939558	18	46278591		rs1522374	က	152235530		7.72	0.03	0.27	0.07	
MBNL1	ILMN_2313158	က	rs6128397	20	57253132		rs16864367	က	152234166		7.22	1.34	1.15	1.73	
MBNL1	ILMN_2313158	က	rs7710738	IJ	22101322		rs13069559	က	152187431	MBNL1	7.92	2.55	7.89	9.28	
MBP	ILMN_2331544	18	rs6079849	20	15462611		rs2051344	18	74715653	MBP	6.26	0.10	0.03	0.02	
MBP	ILMN_2398939	18	rs139568	22	42210985		rs2051344	18	74715653	MBP	5.56	0.03	0.23	0.02	
MBP	ILMN_2398939	18	rs2051344	18	74715653	MBP	rs1125539	က	155204939		5.79	0.02	0.76	0.27	
MBP	ILMN_2398939	18	rs2051344	18	74715653	MBP	rs2619046	io.	55097534		6.03	0.15	0.50	0.26	
MBP	ILMN_2398939	18	rs4805021	19	33436367		rs2051344	18	74715653	MBP	5.82	0.03	0.47	0.14	
MBP	ILMN_2398939	18	rs8092433	18	74747424		rs4890876	18	74732087		5.40	2.06	21.91	28.73	0.015
MEGF9	ILMN_2290118	6	rs13039689	20	51922071		rs966396	6	123453281	MEGF9	4.63	1.13	1.33	1.71	
MFN2	ILMN_1651385	-	rs7989895	13	109401737		rs4846085	-	12050634	MFN2	5.76	0.61	0.25	0.41	
MGC13057	ILMN_1787526	7	rs12718598	7	50428445	MGC13057	rs11725347	4	171860973		5.81	0.13	0.30	0.14	
MGC13057	ILMN_1787526	61	rs674608	18	69070772		rs12718598	<u>-</u>	50428445	MGC13057	5.57	0.07	1.03	0.50	
MGC13057	ILMN_1787526	21 6	rs8058318	16	82628245		rs12718598	2	50428445	MGC13057	7.05	0.11	0.12	0.02	
MGC72104	ILMN-1688318	50	rs845787	207	26197931	MGC72104	rs2660665	ю.	137526799		4.17	0.05	0.08	0.02	
MGST3	ILMN-1751956	٠,	rs740441	1.7	55779644		rs4147592	⊣ 1	165600146	MGST3	5.45	0.57	0.27	0.40	
MPZL2	ILMN_1752932	Ξ:	rs1805	11	118076069	MPZL2	rs11771552	٠;	154708716		5.90	0.01	0.23	0.04	
MPZLZ	ILMN-1752932	TT.	rs/316716	7 .	19953193		rs1805	Ξ,	118076069	MPZLZ	5.64	0.97	1.08	1.35	
MRPL36	ILMN_1800197	٠.	rs17469061	10	8436432		rs750495	٠. د	1782046	MRPL36	6.89	0.34	0.18	0.19	
MRPL43	ILMIN-2258774	01	rs6564769	97	80641040		rs2863095	07;	102746503	MRPL43	5.71	0.26		0	
MRPL52	ILMN_1713966	14	rs1950857	14	26710271		rs3811188	14	0.00	MRPL52	6.56	0.14	0.44	0.22	
MRFSIO	ILMIN_1663664	0 0	rs10955512	000	110202230		rs/22269	٥٥	42194916	MRPSIO	7.48	0.46	0.70	0.64	
MRPS10	ILMN_1663664	9 0	rs11698155	50	15063214		rs2395803	9 0	42158596	MRPS10	6.85	0.31	0.63	0.46	
MRPS10	ILMN_1663664	9 ;	rs1420537	16	52453567		rs13217993	9	42164401	MRPS10	6.21	0.41	0.25	0.28	
MTMR15	ILMN_2152178	15	rs7178375	15	31215935	M.I.MK10	rs12431444	4.	42068689		5.18	1.87	1.87	2.86	
MXI	ILMN_1662358	77.7	rs459498	77.	42795027		rs11160227	14	95514596		6.31	0.46	0.52	0.50	
MAI	TIMIN_1002358	7 5	rs459498	77.5	42795027		rs4973801	ء د	26706382		0.00	0.11	0.50	0.73	10 401
MVBDC3	ILMIN-1002338	- F	rs409496	7 -	61593110		rs6130120	7 -	47486885	MVBDC3	. r.	0.13	0.92	0.00	105.01
MVRPC3	II.MN 1781184	: :	re7322768	# E	109550561		re7124681	: :	47529947	MVBPC3	20.00	0.15	0#:0 0	000	
MYOMI	II.MN 1680344	1 00	rs4798075	2 ~	3247256	MYOMI	rs2737422	- oc	134485237	S 17 1 W	6.02	0.0	0.00	0.00	
N4BP1	ILMN_2201966	16	rs12444224	16	87580855		rs11649236	16	48632478	N4BP1	45.55	2,00	0.59	1.77	38.948
NAAA	ILMN_1668605	4	rs2707575	7	147638723		rs6826085	4	76870229	NAAA	5.65	0.20	0.03	0.04	
NAAA	ILMN_2391512	4	rs2071856	22	37770630		rs6826085	4	76870229	NAAA	5.46	0.27	0.43	0.30	
NAPRT1	ILMN_1710752	œ	rs2123758	œ	144663661	NAPRT1	rs2786014		234897243		80.9	0.07	0.48	0.18	
NAPRTI	ILMN_1710752	00 (rs2123758	oo o	144663661	NAPRTI	rs3889129	οo •	144613680		8.45	15.12	16.08	30.77	0.050
NAPKII	ILMIN-1710752	x 0 0	rs2123758	x 0 0	144663661	NAPRII	rs4862705	4.0	187445552		5.62	1.27	0.19 0.76	18.0	
NAPRTI	ILMN 1710752	0 00	re9193758	o o	144663661	NAPRTI	rs0400333	4 c	146189057		0.12	0.07	0.70	2 77	
NAPRTI	ILMN_1710752	oc	rs2123758	oc	144663661	NAPRTI	rs7571561	- 2	213386267		6.03	0.13	0.47	0.23	
NAPRT1	ILMN_1710752	œ	rs2208123	22	48214812		rs2123758	œ	144663661	NAPRT1	6.60	0.29	0.88	0.63	
NAPRT1	ILMN_1710752	00	rs4743420	6	103488089		rs2123758	œ	144663661	NAPRT1	5.50	0.12	0.17	80.0	
NAPSA	ILMN_1784040	19	rs1405655	19	50882619	NAPSB	rs930280	6	98391111		5.58	0.82	0.10	0.40	
NAPSB	ILMN_2109416	19	rs1405655	19	50882619	NAPSB	rs10882406	10	95976932		5.58	0.67	1.10	1.12	
NAPSB	ILMN_2109416	19	rs1405655	19	50882619	NAPSB	rs7577137	C1 (234721287		5.58 8.50 8.50 8.50	2.11	0.44	1.71	0
NCL	ILMN_2121437	21 5	rs7563453	21 6	232301670		rs4973397	21 0	232291471	0.44	7.31	7.51	6.33	12.70	0.010
NDOFAL	ILMIN_1737738	7 5	rs2/469/1	77.	37101890	NIMETO	rs11107847	21 0	163114006	NDOFAIZ	80.00	0.39	0.18	0.72	
NODS	ILMN 1762594	19	rs2967636	61	7067773	7 7 77 7 7	rs9302752	9	50719103	NOD2	# 06:25	0.24	0.04	90.0	
NRBF2	ILMN_3237385	10	rs11063498	12	5209048		rs7923609	10	65133822	NRBF2	5.45				
NRBF2	ILMN_3237385	10	rs2375269	11	69876894		rs7923609	10	65133822	NRBF2	5.53				

Table S1 - continued from previous page

Probe Prop. Prop	Expression trait				SNP 1				SNP 2		Interact	Interaction statistic /	- log10 p-values	values	
10 reduction decided 4	Probe ID ^b	Chr.	rs ID	Chr.	Pos/Mb^{c}	Associationd	rs ID	Chr.	Pos/Mb^{c}	Associationd		Fehrmann ^f	$EGCUT^{t}$	Metag	Distance / Mb ^h
1 10,000	ILMN_3237385	10	rs6025645	20	56157341		rs7923609	10	65133822	NRBF2 NRBF2	5.45				
8 minoson mino	ILMN_1800897	1	rs4852124	- 61	240680022		rs6588415	1	52334047	MINDE	6.13	0.47	0.02	0.17	
12 nillididadi ilitatis 11 11486050 nillididadi ilitatis 11 11486050 nillididadi ilitatis 11 11486050 0AST 413 0.55 0.00 0AST 0.00 <td< td=""><td>ILMN_1787885</td><td>œ</td><td>rs5017351</td><td>11</td><td>25453482</td><td></td><td>rs1005901</td><td>œ</td><td>21964378</td><td>NUDT18</td><td>5.44</td><td>0.03</td><td>0.46</td><td>0.15</td><td></td></td<>	ILMN_1787885	œ	rs5017351	11	25453482		rs1005901	œ	21964378	NUDT18	5.44	0.03	0.46	0.15	
12 mistages m	ILMN_1658247	12	rs11613438	12	113480510		rs1047944	9	163997467		8.59	1.27	1.55	2.03	
10. 1.00 1	ILMN_1658247	12	rs13311	12	113448652		rs2072133	12	113409260		4.13	4.12	0.81	3.86	0.039
1 17,8555507 2 17,755469 CSPP1 CSP	ILMN_1675640	77.	rs2892233	61	49160255		rs3741981	7.	00000	OASI	4.38	0.87	0.46	0.76	
11 17,220,079 2.1 2.00,024.23 2.00,024.24 2.00	ILMN-2381899	01	rs7192613	16	74286646		rs17512962	01	13169066	OFTN	5.64	0.42	0.06	0.14	
9 FATABOLIS DE CONTRILIS PATABOLIS DE CONTRILICATION FATABOLIS DE CONTRILICATION </td <td>ILMN_2307032</td> <td>11</td> <td>rs2829679</td> <td>21</td> <td>26662543</td> <td></td> <td>rs998639</td> <td>11</td> <td>3149249</td> <td>OSBPL5</td> <td>5.00</td> <td>0.36</td> <td>0.00</td> <td>0.07</td> <td></td>	ILMN_2307032	11	rs2829679	21	26662543		rs998639	11	3149249	OSBPL5	5.00	0.36	0.00	0.07	
1 FAZZASTO 1 CONDENS CONDENS 1 CALL CALL <td>ILMIN_1742456</td> <td>n 0</td> <td>rs17780195</td> <td>1.7</td> <td>70624189</td> <td></td> <td>rs22/37/0</td> <td>ומ</td> <td>77755469</td> <td>CSTFI</td> <td>5.42</td> <td>0.16</td> <td>0.87</td> <td>0.49</td> <td></td>	ILMIN_1742456	n 0	rs17780195	1.7	70624189		rs22/37/0	ומ	77755469	CSTFI	5.42	0.16	0.87	0.49	
1 0.00000000 1.00000000 1.00000000 1.000000000 1.0000000000	ILMN-1742456	n ,	rs2273770	n ,	77755469	OSTFI	rs7718088	Ω,	179590952		5.42	1.20	80.0	0.62	000
1 1	ILMN_1734542	-	rs10802822	-	240132968		rs1264898	_	111992823	OVGP1	5.43	0.13	1.48	0.88	128.140
5 ##3248340 5 ##324840 6 ##324840 6 ##324840 7 ##324840 7 ##324840 7 ##324840 8 ##324840 9 PAM ##32440 PAM ##324840 ##3248	ILMN_1734542	- 1	rs347331	n :	140148107		rs1264894	-	111969719	CVGFI	6.04	0.25	1.21	0.82	
15 FRANKSHOUND 1 JARY 2019 PEX.D A.18 A.18 <td>ILMN_2313901</td> <td>ı n</td> <td>rs28092</td> <td>io i</td> <td>102149795</td> <td>PAM</td> <td>rs784600</td> <td>- 0</td> <td>40139553</td> <td>HPCAL4</td> <td>5.59</td> <td>0.66</td> <td>0.44</td> <td>0.59</td> <td></td>	ILMN_2313901	ı n	rs28092	io i	102149795	PAM	rs784600	- 0	40139553	HPCAL4	5.59	0.66	0.44	0.59	
12 12 12 12 12 12 12 12	ILMN_1815951	o	rs2438490	c	148726162	PCYOXIL	rs2731939	n	21395989		6.20	0.19	0.26	0.16	
12 Fig405797 15 74,246,642 Fig4328748 12 7364442 PEX 5 5.74 0.34 0.09 11 rest3288233 12 49151303 rest3284233 12 49151404 rest3284233 19 40029446 PGLYRP1 rest3288233 19 40029446 PGLYRP1 rest3288233 19 40029446 PGLYRP1 rest3288233 19 40029446 PGLYRP1 rest328233 19 70000 0.00 </td <td>ILMN_1660232</td> <td>12</td> <td>rs10444467</td> <td>12</td> <td>128052636</td> <td></td> <td>rs4329748</td> <td>12</td> <td>7364442</td> <td>PEX5</td> <td>5.85</td> <td>0.09</td> <td>0.71</td> <td>0.32</td> <td>120.688</td>	ILMN_1660232	12	rs10444467	12	128052636		rs4329748	12	7364442	PEX5	5.85	0.09	0.71	0.32	120.688
13 18131090 22 401511030 PGTAPRA 5.64 0.87 0.36 21 18131090 22 140151030 PGCS9467 1.4 2195267 PGAPA 6.51 0.65 0.65 22 1847072 22 3167518 PHKRP 182038876 PGAPA 6.51 0.69 0.60 22 1847072 22 3167518 PHKRP 182038876 PGAPA 6.51 0.60 0.00 22 18470672 22 3199917 PHKRP 6.53 0.00 0.00 22 18470672 22 3199917 PHKRP 6.33 0.00 0.00 22 18470674 22 21918284 17 0.00 0.00 22 18470684 18 18470787 18 1847078 18 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	ILMN_1660232	12	rs7495797	15	27246462		rs4329748	12	7364442	PEX5	5.74	0.34	0.00	0.13	
11 pt.12982333 19 46.52466 PCLYRP1 rs12082367 14 212982367 6.51 0.03 0.05 22 rs4414404 2 3157185 PRIZABA 1 76708086 PHCA 5.51 0.03 0.09 22 rs440440 2 3157185 PISD rs506534 1 1782667 PRD 5.00 0.03 0.09 22 rs440440 2 3157186 PISD rs50404881 1 1.0128697 5.00 0.00	ILMN_1797893	13	rs131969	22	49151303		rs7328733	13	33126737	PFAAP5	5.64	0.87	0.36	0.67	
21 residand 2 11 12007368 PHK3IP1 residand 2 11 12007368 PHKAB 11 12007368 PHKAB 11 12007368 PHKAB 11 12007368 PHKAB 12 12007377 12	ILMN_1704870	19	rs12982353	19	46529456	PGLYRP1	rs1263806	14	21982957		6.51	0.03	0.65	0.24	
2.2 ried/14/14/40 2. 314/75/18/2 products 1 61728/67 1 61728/67 1 61728/67 1 61728/67 1 61728/67 1 1 61728/67 1 1 61728/67 1 1 61728/67 1 <	II.MN 1812552	-	rs493642	=	123097386		rs10736812	-	76708086	PHCA	10	0.36	0 0	0.70	46 389
2.2 ind/10072 2. 20263333 PiSD ind/100833 14 30368867 5.2 0.62 0.87 0.87 2.2 ind/10072 2. 32364031 PiSD ind/10072 2. 32060776 1. 1.0 0.0 <td>11.MN 1719986</td> <td>66</td> <td>ro4141404</td> <td>000</td> <td>31675185</td> <td>PIK3ID1</td> <td>2000000</td> <td>-</td> <td>61798507</td> <td></td> <td>100</td> <td>00.0</td> <td>0.00</td> <td>0 03</td> <td></td>	11.MN 1719986	66	ro4141404	000	31675185	PIK3ID1	2000000	-	61798507		100	00.0	0.00	0 03	
2.2 Fight 10.2 2.2 STATION 2.2 2.2 </td <td>11 Men 1703034</td> <td>1 0</td> <td>10111111</td> <td>1 0</td> <td>99969191</td> <td>T TOTAL</td> <td>12000041</td> <td></td> <td>000000000000000000000000000000000000000</td> <td></td> <td>00.0</td> <td>000</td> <td>0.00</td> <td>0000</td> <td></td>	11 Men 1703034	1 0	10111111	1 0	99969191	T TOTAL	12000041		000000000000000000000000000000000000000		00.0	000	0.00	0000	
2.2 F. 180.1877.2 2.2 3.199.117 F. 1.5 F. 1.5 F. 1.1 O. 0.0 0.1.9 2.2 1.875.187.2 2.2 3.139.187 F. 1.5 1.1 1.1 1.1 1.1 1.1 1.1 0.00 0.1.2 0.04 2. 1.875.10.1 5.2 3.324.34.3 1.1 1.0 1.0 0.31 0.0 0.43 1. 1.810.10.9 2.0 4.955.20.9 PPERS 5.5 0.05 0.0	ILMIN_1,93934	7 0	2100153	7 0	10100270	FISH	FSIO490313	# ·	0.000000		0.70	0.02	0.0	0.00	
2 ref.15572 2 32248347 First 4.12 0.05 0.42 2 ref.15572 2 18087847 Pirst 0.04 4.12 0.05 0.04 9 ref.15579 1 185781604 ref.28046 9 14087108 PNEAT 5.15 0.05 0.04 1 ref.1231403 15 185781604 ref.28046 9 140887108 PPERBY 5.15 0.05 0.04 1 ref.1231603 15 18589647 ref.1210009 1 212447167 PPERBY 5.15 0.03 0.04 1 ref.12402256 12 18589044 ref.1210009 1 212447167 PPERBY 5.65 0.03 0.04 1 ref.12402256 12 185030044 ref.1210009 1 21244767 PPERBY 5.65 0.03 0.03 1 ref.1240009 1 21244767 PPERBA 5.75 0.08 0.03 1 <	ILMIN_I 793934	7.7	rsp518752	7.7	31999127	FISD	rs954627	-	18236681		7.11	0.00	1.19	0.48	
2 res6869411 5 LSRSK1604 res407884 2 219182481 PNKD 6:35 0.16 0.704 1 res1163998 6 4527100 res4278604 9 14487108 0.31 0.73 14 res1163998 6 4527109 res4280645 res11156875 1 7559930 PPPERBA 5.63 0.72 0.43 14 res1291019 2 6668255 res1150009 1 212447167 PPPERBA 5.63 0.72 0.43 1 res1291009 1 212447167 PPPERBA 5.63 0.72 0.43 1 res862334 1 107417238 res1120009 1 212447167 PPPPRBA 5.61 0.03 0.13 1 res8622694 1 107417238 res1120009 1 212447167 PPPPRBA 5.61 0.03 0.13 1 res6822694 1 107417238 res1120009 1 212447167 PPPPRBA	ILMN_1793934	7.7	rs715572	7.7	33234931		rs6518754	7.7	32097775	PISD	4.12	0.05	0.42	0.15	1.137
9 res163998 16 4557109 res92804 9 140487108 PPFIBP2 4.44 0.31 0.37 14 res1291019 20 49668256 res92864 19 140487108 6.15 0.33 0.33 14 res12910109 20 5836086 res1120000 1 21447167 PPPRR5A 5.61 0.03 0.048 1 res128365 12 13650604 res12120009 1 212447167 PPPRR5A 5.62 0.05 0.05 1 res188365 16 135000045 res12120009 1 212447167 PPPRR5A 5.65 0.05 0.05 1 res0188325 14 5040442 res12120009 1 212447167 PPPRR5A 5.65 0.03 0.33 1 res0188352 16 1350009 1 212447167 PPPRR5A 5.65 0.05 0.30 2 res0188352 16 1350009 1 212447167 PP	ILMN_1774604	7	rs6869411	S	158781604		rs4672884	7	219182481	PNKD	6.35	0.16	0.04	0.04	
11 re9911019 20 49688255 res475840 PFPRBP2 444 0.29 0.33 14 re9104409 2 49688255 res47864 5.830880 6.836886 1.1 755994609 1.2 21447167 PPPRBA 5.61 0.029 0.42 1 res10390170 2 1.65399647 res12120009 1.21447167 PPPPRBA 5.61 0.05 0.05 1 res622334 1.1 10747238 res12120009 1.21447167 PPPPRBA 5.61 0.05 0.13 1 res622091 1.21247167 PPPPRBA 5.65 0.13 0.05 1 res622093 1.2 1.2447167 PPPPRBA 5.65 0.13 0.06 1 res622093 1.2 1.2447167 PPPPRBA 5.65 0.13 0.06 1 res62200 1.2 1.2447167 PPPPRBA 5.72 0.06 0.13 1 res1212000 1.2 1.2447167 PPPPRBA	ILMN_1662587	6	rs11639998	16	4527109		rs928046	6	140487108	PNPLA7	5.15	0.31	0.78	0.56	
14 rs12914603 15 58350896 rs11168875 14 36198146 PPP2RAA 5.81 0.12 0.44 1 rs12914603 15 5835064 rs11156875 14 36198146 PPP2RAA 5.63 0.72 0.48 1 rs12422255 12 125596064 rs12120009 1 21447167 PPP2RAA 5.63 0.72 0.48 1 rs682334 11 107417238 rs12120009 1 21447167 PPP2RAA 5.63 0.72 0.48 1 rs682334 11 107417238 rs12120009 1 212447167 PPP2RAA 5.63 0.73 0.06 1 rs76757871 6 135030045 rs12120009 1 212447167 PPP2RAA 5.63 0.30 0.30 1 rs7675787 18 1408380 1 12447167 PPP2RAA 5.63 0.36 0.30 1 rs28019823 14 5604880 1 1244716	ILMN_1675656	11	rs911019	20	49668255		rs4758001	11	7559930	PPFIBP2	4.44	0.29	0.33	0.26	
1 rss1020009 1 212447167 PPP2R5A 5.63 0.72 0.48 1 rss1032055 2 166399467 rss12120009 1 212447167 PPP2R5A 5.63 0.72 0.95 1 rs1689083 13 162526691 rs12120009 1 212447167 PPP2R5A 5.65 0.13 0.05 1 rs682334 11 107417238 rs12120009 1 212447167 PPP2R5A 5.65 0.13 0.05 1 rs7871178 9 271444775 rs1000099 1 212447167 PPP2R5A 5.65 0.13 0.05 1 rs7871178 9 27144776 rs1000990 1 212447167 PPP2R5A 5.65 0.13 0.14 1 rs2084545 16 2386776 rs11049773 16 1263860 7.34 0.15 0.14 1 rs2086048 18 43893544 rs11770058 1 4781744 PSMB1 5.74	ILMN_1662617	14	rs12914603	15	58350896		rs11156875	14	35619816	PPP2R3C	5.81	0.12	0.42	0.19	
1 rs182902355 13 125259604 rs121200009 1 212447167 PPP2R5A 5.67 0.08 0.05 1 rs184902355 13 662226904 rs121200009 1 212447167 PPP2R5A 5.67 0.08 0.03 1 rs662334 11 10741728 rs121200009 1 212447167 PPP2R5A 5.65 0.08 0.03 1 rs755777 6 135030045 rs121200009 1 212447167 PPP2R5A 5.65 0.08 0.37 1 rs767777 6 122447167 PPP2R5A 5.72 0.05 0.03 1 rs8019823 14 95040482 rs12020009 1 212447167 PPP2R5A 5.73 0.01 1 rs8019823 14 95040482 rs11000990 11 21244767 PPP2R5A 5.73 0.01 2 rs802834 16 1868980 18 14497346 7.34 0.03 0.44	ILMN_1738784	1	rs10930170	73	166399467		rs12120009	-	212447167	PPP2R5A	5.63	0.72	0.48	99.0	
1 res6889083 13 66222691 res121200009 1 212447167 PPP2R5A 5.61 0.36 0.28 1 res6829083 13 66222691 res121200009 1 212447167 PPP2R5A 5.65 1.60 0.28 1 res7757871 6 135030045 res12120009 1 212447167 PPP2R5A 5.65 1.60 0.38 0.014 1 res7757871 6 135030045 res11200099 1 212447167 PPP2R5A 5.65 0.36 0.37 0.06 1 res1282355 16 42867776 res1060990 1 212447167 PPP2R5A 5.67 0.14 0.00 0.35 1 res1282355 16 42867776 res11701058 21 47776382 5.73 0.15 0.03 0.03 2 res10803372 2 47776382 2210RF57 res11701058 21 47776382 5.79 0.05 0.05 6	ILMN_1738784	1	rs12423255	12	123595064		rs12120009	-	212447167	PPP2R5A	5.72	0.08	0.95	0.46	
1 rs652334 1 107417238 rs12120009 1 212447167 PPP2R5A 5.65 1.69 0.28 1 rs7571778 9 27144475 rs12120009 1 212447167 PPP2R5A 5.95 0.16 0.06 1 rs7571778 9 27144475 rs12120009 1 212447167 PPP2R5A 5.95 0.16 0.06 1 rs28019823 14 95040482 rs1100099 1 212447167 PPP2R5A 5.72 0.16 0.03 1 rs28019823 2 2887776 rs1000990 1 212447167 PPP2R5A 5.73 0.06 0.11 2 rs2801923 2 47931653 C210RF57 rs1107058 2 777474 PSMB1 7.34 0.05 0.14 5 rs2802954 1 47087682 2 17087744 PSMB1 5.14 0.04 0.21 6 rs6008980 2 170877444 PSMB1	ILMN_1738784	1	rs1889083	13	66222691		rs12120009	-	212447167	PPP2R5A	5.61	0.36	0.13	0.17	
1 res7757871 6 135030045 res12120009 1 212447167 PPP2R5A 5.95 0.37 0.06 11 res7757871 6 271444475 res12120009 11 212447167 PPP2R5A 5.95 0.37 0.08 11 res8019823 14 95040482 res11600990 11 64082807 PRDX5 6.43 0.81 0.14 15 res288372 21 47931653 C210RF57 res16407346 6.43 0.63 0.03 2 res28839372 21 47031653 C210RF57 res1600934 PSMB1 5.60 0.19 0.03 2 res28839372 21 42062843 6 17080084 PSMB1 5.14 0.00 0.03 6 res6060830 18 43983354 PSMB1 res282643 6 17080084 PSMB1 5.14 0.00 0.20 6 res6060830 20 30347824 PSMB1 res2826415 6	ILMN_1738784	1	rs682334	11	107417238		rs12120009	Т	212447167	PPP2R5A	5.65	1.69	0.28	1.21	
1 resp8719278 9 27144475 res12120009 1 210442867 PPP2R5A 5.72 0.16 0.30 16 res2188355 16 23867776 res1060990 1 6442887 PRDX5 6.43 0.14 0.14 21 res2188355 16 23867776 res1060990 1 612639800 7.34 0.15 0.13 21 res2188355 16 23867776 res1049273 16 1263980 7.34 0.53 0.11 21 res2080371 21 47931653 C210RF57 18 3149746 PSMB1 5.79 0.05 0.14 6 res6060330 20 31347816 res12207114 6 17682379 PSMB1 5.74 0.05 0.44 6 res6060330 20 31347846 res1220844 PSMB1 5.74 0.44 0.21 7 12 12852843 6 17685423 1 17682379 PSMB1 5.44	ILMN_1738784	Т	rs7757871	9	135030045		rs12120009	1	212447167	PPP2R5A	5.95	0.37	90.0	0.12	
11 res6019823 14 95040482 res11600990 11 64082807 PRDX5 6.43 0.81 0.14 16 res1029231 21 473467776 res0402739 16 1263900 7.34 0.53 0.01 0.03 21 res283972 21 47931653 C21ORF57 res928437 21 4777340 5.60 0.19 0.03 21 res2839372 21 47931653 C21ORF57 res1207114 PSMB1 5.79 0.03 0.044 6 res4890648 18 43983954 res13207114 PSMB1 5.79 0.00 0.04 6 res608030 20 30047823 res13207114 6 17083739 PSMB1 1.0574744 PSMB1 5.14 0.00 0.26 6 res608030 20 30047823 res12207144 PSMB1 5.14 0.00 0.26 7 4 17082379 1 270237957 res122825 PTDSS1	ILMN_1738784	1	rs7871178	6	27148475		rs12120009	1	212447167	PPP2R5A	5.72	0.16	0.30	0.16	
16 res188355 16 22867776 res1049279 16 12639800 7.34 0.53 0.11 21 res108355 21 42038653 C210RF57 res049377 18 34938653 6.019 0.59 0.19 21 res283972 21 4803865 C210RF57 res048377 4.81 0.03 0.44 6 res3802648 18 43983954 res038343 6 17080384 PSMB1 5.14 0.00 0.26 6 res060030 20 3034782 res0298443 6 17080384 PSMB1 5.14 0.04 0.26 6 res060030 20 3034782 res0206415 6 170823379 PSMB1 5.14 0.04 0.05 12 res060030 20 3034782 res10320714 6 17087744 PSMB1 5.14 0.04 0.05 12 res060030 20 3034782 res10320714 6 17087744 PSMB1	ILMN_1711606	11	rs8019823	14	95040482		rs11600990	11	64082807	PRDX5	6.43	0.81	0.14	0.44	
21 res1029321 21 47931653 C21ORF57 18 31497346 5.60 0.19 0.03 6 res2802323 1 47931653 C21ORF57 18 47777344 PSMB1 5.76 0.19 0.04 6 res3802607 11 121774705 res922843 6 170877444 PSMB1 5.74 0.00 0.26 6 res4800648 18 43983854 res922843 6 17089784 PSMB1 5.14 0.00 0.21 6 res6028843 6 res6028843 6 17089784 PSMB1 5.14 0.00 0.21 6 res6028843 6 res6028843 6 170890384 PSMB1 6.14 0.00 0.26 12 res6028846 13 res10307114 6 170879785 PPDSS1 5.00 0.03 0.44 12 res631562 11 126852438 res1036212 11 5221825 PTDSS1 5.70	ILMN_1713603	16	rs2188355	16	23867776		rs10492793	16	12639800		7.34	0.53	0.11	0.25	11.228
21 rs2839372 21 48068862 rs11701058 21 4775382 C210RF57 4.81 0.69 4.47 6 rs386267 11 121774705 rs13207114 6 17087744 PSMB1 5.79 0.04 6 rs488626843 2 3034782 rs6928445 6 17082379 PSMB1 5.14 0.00 0.26 6 rs6060830 20 3034782 rs780714 6 17082379 PSMB1 0.04 0.05 6 rs6060803 2 3034782 rs7106083 6 17082379 7 4.58 0.04 0.02 12 rs6060803 2 3034782 rs7106083 1 2721825 PSMB1 6.14 0.00 0.03 12 rs608020 1 76588123 rs11036212 1 5221825 PTDSS1 5.00 0.03 0.08 12 rs631562 1 1 7221825 PTDSS1 5.70 0.03	ILMN_1675038	21	rs1029231	21	47931653	C21ORF57	rs958127	18	31497346		5.60	0.19	0.03	0.04	
6 res862667 11 12177476 res13207114 6 170877444 PSMB1 5.79 0.44 0.24 6 res60936 20 30347832 res0295415 6 170823379 PSMB1 5.14 0.04 0.26 6 res60936 20 30347832 res295415 6 170823379 PSMB1 5.14 0.04 0.21 6 res60936 20 30347832 res276964 1 22579797 5.44 0.44 0.21 12 res635367 14 9478823 res1030714 6 170823379 PSMB1 5.42 0.32 12 res631562 17 7658423 res1030714 1 5221825 PTDSS1 5.00 0.03 0.43 12 res631562 17 765842348 res10020773 4 17526853 QDPR 5.75 0.02 0.03 13 res631562 1 76521825 PTDSS1 5.70 0.02	ILMN_1675038	21	rs2839372	21	48063862		rs11701058	21	47776382	C21ORF57	4.81	0.69	4.47	4.06	0.287
6 re4890648 18 43983644 PSMB1 FSMB1 5.14 0.00 0.26 6 re5028643 6 170890384 PSMB1 FSMB1 FS.14 0.00 0.26 6 re5028643 6 170829384 6 170829384 6 170829384 6 170829384 6 170829384 6 1708744 7542 1.35 0.64 1 re3728367 1 31727816 re3120714 6 1708744 PSMB1 5.42 1.35 0.64 0.63 1 re3789276 1 221825 PTDSS1 5.00 0.08 0.68 1 re438162 1 76598123 re11036212 11 5221825 PTDSS1 5.00 0.08 0.08 1 re438162 1 76598123 1 re11036212 11 5221825 PTDSS1 5.70 0.03 0.48 1 re4042788 RABACI re7050277 1 70	ILMN_1789176	9	rs3862607	11	121774705		rs13207114	9	170877444	PSMB1	5.79		0.44		
6 res0060830 20 30347832 PSMB1 5.44 0.44 0.1 6 res0608330 20 3034783 PSMB1 res99545 6 17087344 PSMB1 4.58 1.18 0.54 0.64 6 res729749 12 131727816 res220826 1 257482 1.18 0.32 12 res238367 14 5658123 res10320714 6 17087744 PSMB1 5.40 0.04 0.32 12 res238367 14 5658123 res103321 1 5221825 PTDSS1 5.00 0.03 0.08 12 res031562 17 7658123 res1036212 1 5221825 PTDSS1 5.70 0.02 0.03 0.08 12 res031562 1 762842438 res1036307 1 70233726 QDPR 5.75 0.02 0.03 12 res041730 2 3337574 res736582 QDPR 1 2.75 <td>ILMN_1789176</td> <td>9</td> <td>rs4890648</td> <td>18</td> <td>43983954</td> <td></td> <td>rs6928843</td> <td>9</td> <td>170890384</td> <td>PSMB1</td> <td>5.14</td> <td>00.0</td> <td>0.26</td> <td>0.04</td> <td></td>	ILMN_1789176	9	rs4890648	18	43983954		rs6928843	9	170890384	PSMB1	5.14	00.0	0.26	0.04	
6 rs6928843 6 170890384 PSMB1 rs2769959 1 225797957 4.58 1.95 0.64 12 rs7239674 12 131727816 rs12207114 6 17087744 PSMB1 5.42 1.95 0.64 12 rs238367 14 9.5478823 rs1038212 11 5221825 PTDSS1 5.00 0.03 0.48 12 rs4669205 17 76584246 rs1008212 11 5221825 PTDSS1 5.70 0.03 0.48 12 rs4669205 17 76584246 rs1008212 11 5221825 PTDSS1 5.70 0.03 0.48 12 rs491762 6 106348246 rs10020773 4 17526682 QDPR 5.75 0.03 0.46 12 rs2404788 RABACI rs78051628 11 120174174 6.42 0.25 0.03 11 rs9931702 16 55526551 AKTIP rs18492379 11 <td>ILMN_1789176</td> <td>9</td> <td>rs6060930</td> <td>20</td> <td>30347832</td> <td></td> <td>rs9295415</td> <td>9</td> <td>170823379</td> <td>PSMB1</td> <td>5.44</td> <td>0.44</td> <td>0.21</td> <td>0.27</td> <td></td>	ILMN_1789176	9	rs6060930	20	30347832		rs9295415	9	170823379	PSMB1	5.44	0.44	0.21	0.27	
6 res7299749 12 137727816 res13207114 6 170877444 PSMB1 5.42 1.18 0.32 12 res2396774 1 1.2085243 res1036212 11 5221825 PTDSS1 5.90 0.08 0.08 12 res631602 1 76598123 res11036212 11 5221825 PTDSS1 5.90 0.08 0.08 12 res631602 1 76598138 res11036212 11 5221825 PTDSS1 5.90 0.08 0.08 4 res631602 1 765982438 res11036212 11 5221825 PTDSS1 5.70 0.08 0.08 1 res041730 2 33375704 res10020773 1 7723726 QDPR 6.55 0.25 0.08 1 res042279 1 27023726 QDPR 6.38 0.03 0.31 1 res0422579 1 32136436 RCNI res14740645 6.42 0.04	ILMN_1789176	9	rs6928843	9	170890384	PSMB1	rs2769689	1	225797957		4.58	1.95	0.64	1.78	
12 res255367 14 99478823 res1036212 11 5221825 PTDSS1 5.00 0.03 0.48 12 res631562 11 12685423 res11036212 11 5221825 PTDSS1 5.70 0.02 0.03 12 res631562 11 12685438 res11036212 11 5221825 PTDSS1 5.70 0.02 0.03 12 res494676 6 106342846 res10020773 4 1752682 QDPR 5.75 0.02 0.03 19 res1075738 12 res1023726 17 7026117 6.55 0.25 0.05 16 res2037702 16 5526551 AKTIP res166344 15 20638488 RCNI 6.33 0.03 0.31 11 res1087913 12 RCNI res10874645 1102740645 4.32 0.04 0.06	ILMN_1789176	9	rs7299749	12	131727816		rs13207114	9	170877444	PSMB1	5.42	1.18	0.32	98.0	
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4 res4946705 6 106348246 res10020773 4 17526682 QDPR 5.75 1.03 1.25 12 res421730 22 33375704 res736507 12 70235726 6.55 0.28 0.28 0.084 19 res045788 19 45462788 RABACI res1863464 15 226938488 6.38 0.03 0.31 11 res0831702 16 55526551 AKTIP res1863464 15 226938488 6.38 0.03 0.31 11 res10875911 12 213343486 RCNI res192579 11 32136436 RCNI 8 141174488 0.58 0.03 0.03 11 res4922579 11 32136436 RCNI res11417468 RCNI 6.38 0.04 0.04 0.06	ILMN_1743049	12	rs631562	11	126852438		rs11036212	11	5221825	PTDSS1	5.70	0.05	0.40	0.11	
12 rs241730 22 33375704 rs7305307 12 70235726 6.55 0.25 0.08 19 rs1075728 16 43262788 RAFAP rs765344 15 26938488 6.38 0.03 0.31 11 rs1087702 16 5352651 AKTIP rs4892879 11 32136436 RCNI 6.38 0.03 0.31 11 rs4922579 11 32136436 RCNI rs11416997 8 11177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCNI rs1341899 1 102740645 5.40 0.04 0.26	ILMN_1672443	4	rs4946705	9	106348246		rs10020773	4	17526682	QDPR	5.75	1.03	1.25	1.55	
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16 re9931702 16 5552555 AKTIP rs1863464 15 296934488 6.38 0.03 0.31 11 rs102879131 12 41147155 RCN1 rs19292579 11 32136436 RCN1 5.23 0.58 0.37 11 rs4922579 11 32136436 RCN1 rs11166957 8 14177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCN1 rs1341899 1 102740645 5.40 0.04 0.26	ILMN_2207363	19	rs1075728	19	42462788	RABACI	rs7951628	11	120161117		6.42	0.28	0.84	0.59	
11 rs1087931 12 41147155 RCM1 rs4922579 11 32136436 RCM1 6.23 0.58 0.37 11 rs4922579 11 32136436 RCM1 rs1166957 8 14177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCM1 rs1341899 1 102740645 5.40 0.04 0.26	ILMN_1756999	16	rs9931702	16	53526551	AKTIP	rs1863464	15	26938488		6.38	0.03	0.31	0.08	
11 rs4922579 11 32136436 RCN1 rs11166957 8 141177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCN1 rs1341899 1 102740645 5.40 0.04 0.26	ILMN_1800276	11	rs10879131	12	41147155		rs4922579	11	32136436	RCN1	5.23	0.58	0.37	0.47	
11 rs4922579 11 32136436 RCN1 rs1341899 1 102740645 5.40 0.04 0.26	ILMN_1800276	11	rs4922579	11	32136436	RCN1	rs11166957	œ	141177468		4.32	0.41	0.09	0.17	
	ILMN_1800276	11	rs4922579	11	32136436	RCN1	rs1341899	1	102740645		5.40	0.04	0.26	0.02	

RNASEG	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	SNF Chr.	SNE	SNP 1 Pos/Mb	l 10	Associationd	rs ID	Chr.	SNP 2 Pos/Mb ^c	Associationd	Interac	Interaction statistic / SGS ^e Fehrmann ^f	$-\log_{10} p$ -values EGCUT ^f Met	values	Distance / Mbh
1 177097200 1 13744120	II.MN 1802380	-	rs4982958	14	24987865		re301819	-	8501786	RERE	5 66	0.61	1 23	1 17	\
1 111016529 19 131743131 1317431 1317431 131743131 131743131 131743131 131743131 131743131 131743131 131743131 131743131 13174	80		rs7697290	4	135248366		rs301819		8501786	RERE	5.74	0.14	0.10	0.06	
1 11 12 11 12 11 12 11 12 11 12 11 12 11 12 11 12	795	-	rs11085829	19	13174312		rs301819		8501786	RERE	5.12	0.21	0.33	0.21	
14 11107232 14 21102320 14 21102320 14 21102320 14 21102320 14 21102320 15 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 24100008 16 241008 16 241	795		rs3852011	33	112844086		rs301819	-1	8501786	RERE	5.71	80.0	09.0	0.26	
Table Tabl	533	14	rs11628398	14	21182800	RNASE6	rs7324365	13	100601327	A NO	5.48	0.42	0.21	0.26	
1	726	17	rs238230	17	4875566		rs4884857	13	54668512	MIN ASEO	4.37	60.0	0.44	0.0	
1 Inchestivation 1 colorage and col	726	17	rs400688	17	4839930	RNF167	rs11706900	က	36348968		5.59	0.71	0.46	0.64	
1 resolvation 1 0.01833424 4.32 1.28 1.28 1 resolvation 1 6.0000228 1.00000028 1.000000028 1.100000000000000000000000000000000000	347		rs1107121	21	46127549		rs2819365	1	201983242		6.27	0.11	0.30	0.13	
1	347	- ;	rs8071611	17	67153386		rs2819365	- ;	201983242		4.32	1.48	0.52	1.28	1
1	278	16	rs352935	16	89648580		rs2965817	16	89513234	500 100	4.98	3.79	14.41	17.24	0.135
1	033	V 5	rs1401202	1 7	50103816	P D I 36 A I	rs4849261	N 0	1380380028	LESAL!	0.00 7.00	0.13	0.13	0.00	
8 rings6642 8 145964615 RPLS rings6642 8 1459647 0.10 0.37 0.15 8 rings6642 8 145964615 RPLS rings6642 8 14596473 0.10 0.10 0.15 0.15 8 rings6214 16 80913946 rings6456 11 91400111 SESNA 5.00 0.22 1.77 0.15 11 rin705528 5 1 91400111 SESNA 5.00 0.22 0.73 0.15 11 rin7055349 1 91400111 SESNA 5.00 0.22 0.73 0.15 11 rin705405 1 91400111 SESNA 1.70 0.22 0.73 0.70 0.22 11 rin705405 1 1.70 1.70 0.22 0.71 0.70 0.71 0.70 0.71 11 rin705405 1 1.70 1.70 1.70 0.72 0.71 0.72 <t< td=""><td>936</td><td>1 4</td><td>rs4900928</td><td>1 4</td><td>50020817</td><td>RPL36AL</td><td>rs1502991</td><td>n c</td><td>66137260</td><td></td><td>, r.</td><td>0.03</td><td>0.00</td><td>0.0</td><td></td></t<>	936	1 4	rs4900928	1 4	50020817	RPL36AL	rs1502991	n c	66137260		, r.	0.03	0.00	0.0	
8 re41485874 20 re4148174 20 <td>721</td> <td>00</td> <td>rs2958482</td> <td>00</td> <td>145984615</td> <td>RPL8</td> <td>rs1619856</td> <td>-</td> <td>234585790</td> <td></td> <td>4.59</td> <td>0.10</td> <td>0.37</td> <td>0.15</td> <td></td>	721	00	rs2958482	00	145984615	RPL8	rs1619856	-	234585790		4.59	0.10	0.37	0.15	
3 re488214 16 re488214 16 re488214 16 re488214 17 re488214 16 re488214 17 re488214 16 re488214 17 re484366 11 16/44237 5 0.02 0.02 0.01 11 re456396 11 4040111 SESNA 5 0.02 0.02 0.01 0.01 11 re653396 11 4040111 SESNA 5 0.02 0.01	721	00	rs4143674	20	4741304		rs2958482	œ	145984615	RPL8	4.33	0.13	0.45	0.22	
1	.880	က	rs4889214	16	80913946		rs696221	က	10342876	SEC13	6.48				
11 1875/2474 144 1444/1237 18684866 11 94006411 SESNA 5.50 0.02 0.015 12 1875/2474 144 1444/1237 18684866 11 94006411 SESNA 5.50 0.02 0.015 14 1875/2435 15 94006111 SESNA 144006425 144	2787		rs17085428	n	95388015		rs7695		156147326	SEMA4A	5.70	0.22	1.73	1.17	
11 1858359 1 4090511 1 4090502 1 4090511	1027	= :	rs12147460	14	104412137		rs684856	11	94906111	SESN3	5.50	0.02	0.51	0.15	
1	1027	1:	rs355391	G :	46591793	OT COL	rs684856	Ξ.	94906111	NENNS	59.67	0.31	0.06	0.10	
6 FAZIONOSTIA 1 CORRESPONDE CONTRACTOR	1707	11	rs084850	1:	94900111	DEDING	rs/00494/	юс	134000425	ממממ	00.0	0.21	0.51	0.31	
6 res645504 4 SSSSSSCEC res1345044 4 SSSSSSCE res1345044 5 64645504 PPBP 5.23 0.52 0.71 0.53 20 res163583 2 1 612319 SIRPC res644739 1 2023826 5.774 0.09 0.24 0.13 20 res167356 1 2923826 SLC22A18 res67473 7 15224179 5.47 0.09 0.24 0.13 11 res67636 1 2923826 SLC22A18 res711054 7 15224179 5.47 0.09 0.13 0.14 0.03 0.14 0.03 0.14 0.13 0.14 0.14 0.14 0.14 <td< td=""><td>2764</td><td> o</td><td>rs2545385</td><td>1 10</td><td>66383979</td><td></td><td>rs1354034</td><td>0 00</td><td>56849749</td><td>PPBP</td><td>5.97</td><td>0.70</td><td>0.51</td><td>0.30</td><td></td></td<>	2764	 o	rs2545385	1 10	66383979		rs1354034	0 00	56849749	PPBP	5.97	0.70	0.51	0.30	
9 res103420 2 10 180922 Co.18 0.13 0.13 0.13 11 res103420 2 1612819 SIRPG res447551 9 1317826 5.74 0.29 0.18 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.13 0.10 0.00 0.10 0.00 0.10 0.00 0.10 0.00	764	9	rs6845304	4	88280502		rs1354034	· m	56849749	PPBP	5.23	0.32	0.71	0.53	
20 re1555883 20 fer8847795 4 60489510 5.74 0.29 0.18 0.17 11 re367035 11 2923826 51,24198 4 60485016 5.77 0.09 0.24 0.07 11 re367035 11 2923826 SLC22A18 re310844 7 15324179 5.77 0.09 0.19 0.01 11 re367035 11 2923826 SLC22A18 re3107136 3 125601067 SLC4143 5.86 0.19 0.01 0.00 1 re3695508 8 140233774 SLC45A4 re7710166 3 215601067 SLC4143 5.86 0.09 0.01 0.00 1 re3695508 1 2923826 SLC22A18 re37710166 13 29285949 SLC4143 5.86 0.09 0.01 0.01 1 re3695209 1 re3695349 SLC444 re174097 1 17450499 SLC46 0.09 0.05	336	6	rs1034120	21	18196922		rs17455517	6	131785369	SH3GLB2	7.40	0.22	0.18	0.13	
11 residencia 1 color color color color 11 residencia 19 52181798 ELC22A18 residencia 51.70 0.09 0.04 0.00 11 residencia 11 2923826 ELC22A18 residencia 6.15 0.03 0.01 0.00 1 residencia 11 2923826 ELC22A18 residencia 6.15 0.03 0.01 0.00 8 re698568 8 142337734 SLC45A4 re771016 5 17469877 6.05 0.07 0.05 0.05 1 re698568 8 142337734 SLC45A4 re771016 5 17469877 6.05 0.07 0.05 0.06 0.05 1 re698568 8 142337734 SLC45A4 re771016 5 17469877 5 0.07 0.09 0.05 0.06 0.09 0.05 0.09 0.06 0.05 0.07 0.09 0.05 0.	1801	20	rs1535883	20	1612819	SIRPG	rs6842739	4	60489510		5.74	0.29	0.18	0.17	
11 reseR07035 11 2928826 SLC22A18 res1010874 7 153224179 6.15 0.15 0.10 0.06 8 res9R035 11 2928826 SLC22A18 res7R106 24167828 6.15 0.015 0.016 0.06 8 res9R5036 11 2928826 SLC22A18 res7R1106 5 7 0.05 0.05 0.06 18 res9B5508 17 5600203 SLC45A4 res7R1106 5 0.09 0.06 0.06 0.06 13 res9B5506 17 5600203 SMCA 6.11 0.09 0.05 0.06 0.06 20 res1040325 17 182834903 SMCA 6.68 0.07 0.06 0.06 20 res10404583 21 1922404 res1040583 1 17201494 0.09 0.05 0.06 20 res1044583 21 19224040 SNORD8 SNORD8 0.03 0.03 0.05	505	11	rs11673260	19	52181798		rs367035	11	2923826	SLC22A18	5.47	0.09	0.24	0.09	
11 res2013656 11 2.923326 SLC22A18 res777103 2.24168523 SLC41A3 6.15 0.39 0.13 0.19 1 res908508 8 142337734 SLC22A18 res777103 2.24168523 SLC41A3 5.95 0.08 0.07 0.19 13 res908508 8 142337734 SLC45A4 re771036 5 7.246A3 5.95 0.08 0.07 0.04 13 res908308 15 97403923 SLC45A4 re770136 5 0.09 0.06 0.07 0.04 0.06 0.07 0.04 0.06 0.07 0.09 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.07 0.09 0.06 0.07 0.09 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.06 0.07 0.09 0.06 0.07 0.01 <td>2505</td> <td>=</td> <td>rs367035</td> <td>11</td> <td>2923826</td> <td>SLC22A18</td> <td>rs3110874</td> <td><u>-</u></td> <td>153224179</td> <td></td> <td>5.70</td> <td>0.15</td> <td>0.10</td> <td>90.0</td> <td></td>	2505	=	rs367035	11	2923826	SLC22A18	rs3110874	<u>-</u>	153224179		5.70	0.15	0.10	90.0	
8 FFEORMSTAND 1 LACKLAAA FSOURTION LACKLAAA FSOURTION LACKLAAA FSOURTION LACKLAAA FSOURTION LACKLAAA FSOURTION LACKLAAAA FSOURTION LACKLAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	2505	11	rs367035	Ξ:	2923826	SLC22A18	rs3772054	01 0	241678528	0 4 17 7	6.15	0.39	0.13	0.19	
1	770	n 0	rs1912136		140007704	OT CAR A	rs6771703	n	174505079	SLC41A3	0 H	0.10	0.82	42.1	
1 FF8035209 1 COLOR COL	0770	0 0	rs0905500	4 0	55609001	SEC45A4	rs//01916	0 6	20250340	ST.CARA3	0 r 0 r 0 r	0.09	0.0	0.40	
20 FF5103252 CALL	2000	2 -	15949600	- 14	93002091		rs/961190		183480003	SMC7	0.0	0.03	0.00	0.20	
4 rsi10521 9 133050233 rs705337 4 19225940 SNHG8 611 C	380	20	rs8118315	20	4161500	SMOX	rs11677815	. 6	65800982	5	2 20 20	0.39	0.62	0.00	
11 \$\text{i}\$ \$150429 15 40250108 \$\text{i}\$ \$150429 15 40250108 \$\text{i}\$ \$150429 15 \$150524462 11 \$\text{i}\$ \$150524462 11 \$1739127 \$\text{i}\$ \$15052434 11 \$17015547 \$\text{i}\$ \$150524462 \$11 \$1739127 \$\text{i}\$ \$1505234 \$\text{i}\$ \$11 \$1739127 \$\text{i}\$ \$110828336 \$\text{i}\$ \$\tex	349	4	rs1105621	6	133050233		rs705837	4	119225940	SNHG8	6.11				
11 re2624462 11 173292442 11 173292442 11 173292442 11 173292442 11 173292442 11 173292446 11 17329244 11 17329244 11 17329244 11 17329244 12 12 12 12 12 12 12	LMN_1799381	11	rs1520429	15	46259108		rs214097	11	17291499	SNORD14A	6.60	0.29	1.03	0.72	
2 res1045863 2 1152982241 res706783 2 101889306 SNORD89 6.08 2 res1045863 1 2 1152986324 res707783 2 1018889306 SNORD89 6.08 15 res134646 21 46377628 SNUPN res178066 ROS 81888906 SNORD89 6.33 0.13 1.41 0.83 15 res134646 21 46376528 SNUPN res1472075 3 193706323 SNORD89 6.35 0.34 0.00 0.06 15 res1314646 21 46376528 SNUPN res1472075 3 193706323 SNORD89 6.35 0.34 0.00 0.06 15 res1700062 1 res1700620 1 75509713 STAT 0.34 0.01 0.05 0.01 20 res1700063 1 res1700630 1 75509713 TVFM 7.05 0.01 0.05 0.01 0.05 16	381	11	rs2634462	11	17339127		rs6486334	11	17015557		7.31	13.11	10.96	23.22	0.324
2 res11008822 11 res1700783 2 101889306 SNORIDS9 6.96 15 res134646 21 46376528 SNUPN ref70783 2 101889306 SNORIDS9 6.35 141 15 res134646 21 46376528 SNUPN ref748836 16 81888905 6.30 6.45 0.13 141 15 res134646 21 46376528 SNUPN ref74786 16 81888905 6.45 0.13 141 15 res131460 19 41117869 res477480 15 456 0.67 0.12 10 res1176006 19 4117869 res477480 1 7569713 5.44 0.01 0.07 20 res11700063 20 46153148 SULF2 res90924 4 180439236 TULFM 5.58 0.57 0.17 16 res609926 20 56013994 res783554 16 2850667 TUFM 7.05	8662	21	rs10445863	21	115929241		rs750783	7	101889306	SNORD89	80.9				14.040
2 restanded solution 2 20.7880 2 101888300 SNOKLDS 6.53 1.41 15 restanded solution 2 4.0576528 SNUPN restanded solution 3 193706336 6.45 0.13 1.41 15 restanded solution 1 4.0576528 SNUPN restanded solution 1 5.59 0.34 0.00 1 restanded solution 1 4.0567628 NUPN restanded solution 1 5.59 0.34 0.00 1 restanded solution 1 4.0567676 1 7.5569713 5.55 0.67 0.12 7 restanded solution 1 4.0569713 7 7.561007 5.51 0.46 0.24 1 restanded solution 1 7.0599236 7 7.565007 7.05 0.01 0.05 1 restanded solution 1 7.0599236 7 7.565007 7.05 0.01 0.05 1 restanded solution	299	71 (rs11605822	Ι,	122986326		rs750783	71 0	101889306	SNORD89	5.96				
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20 rs11700063 20 40153148 SULF2 rs939294 4 180439236 5.51 0.46 0.24 16 rs1463965 18 r43785354 16 28500667 TUFM 7.05 0.01 0.05 16 rs6099626 20 46013994 rs7831863 9 136281753 SURF6 6.14 0.26 0.16 1 rs6099626 20 56013994 rs485485 1 85465299 SVTL22 5.47 0.28 0.16 1 rs8014956 11 95422867 rs4072037 1 155162067 THBS3 5.55 0.03 0.15 1 rs8014956 14 2068796 1 15514459 THBS3 5.55 0.31 0.76	1729	-1	rs4073164	14	104947517		rs17685	-1	75616105	STYXL1	5.88	0.57	0.17	0.31	
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16 rs2886657 21 40119768 rs3788354 16 28550667 TUFM 5.83 0.26 0.14 0.26 0.16 1 rs609966 20 56013994 rs48545 1 8542876 6.14 0.26 0.16 1 rs1939875 11 95422867 rs4072037 1 155162067 THBS3 5.55 0.03 0.15 1 rs8014956 14 20687987 rs2048905 1 155194980 THBS3 5.55 0.03 0.15 1 rs8014956 14 20687987 rs2049803 1 155194580 THBS3 5.55 0.03 0.15 1 rs8014956 14 2068798 rs8204860 1 15519459 THBS3 5.55 0.03 0.15	133	16	rs1463965	18	74332954		rs3785354	16	28550667	TUFM	7.05	0.01	0.05	0.00	
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1 rse183987-5 11 99422867 rs40f2237 155194980 THBS3 5.55 0.13 0.15 1 rs8214956 14 2068797-8 rs2049905 1 155194980 THBS3 5.65 0.31 0.76 1 rs282345 21 1674553 rs41820993 1 168154599 TTPRI, 5.22 0.07 0.40 0.00	6099	Ξ.	rs1375719	13	103410782		rs485485	Ξ,	85495269	SYTL2	5.47	0.28	0.31	0.24	
1 rsQ432445	4003		rs1939875	77	90422807		rs40/203/		155162067	THESS	0.00	0.03	0.15	0.00	
	1663		rs8014956	14	16745522		rs2049805		155194980	THESS	0.00 0.00 0.00	0.31	0.76	0.00	

Probe Dr. Probe Dr. Probe Dr. Probe Dr. Prob Dr. Probe Dr. P	Ch. p 1D Ch. Po.MAP Association Po.MAP Ch. Po.MAP Association Po.MAP Po.MAP<	Expr	Expression trait			01	SNP 1			0.1	SNP 2		Interact	Interaction statistic /	$-\log_{10} p$ -values	values	
INAN 1994	INAN-1784428 19 000000000 10 000000000 10 00000000		Probe ID ^b	Chr.	rs ID	Chr.	Pos/Mb^{c}	Associationd	rs ID	Chr.	Pos/Mb^{c}	Associationd	BSGSe	$Fehrmann^f$	$\mathtt{EGCUT}^{\mathrm{f}}$	Metag	\
LINKLIFFERENCE 19	INAN_1766420		ILMN_1804148	7	rs1940400	11	132389627		rs17725246	7	44581986	TMED4	5.70	90.0	1.34	0.70	
LINAL President 10 Artification 10	ILANAL 1766422 10 10 10 10 10 10 10	149	ILMN_1786426	19	rs2839013	21	47248981		rs8106959	19	36219525	TMEM149	8.11	0.16	0.48	0.26	
INAN_1756426	ILANIAL/TYGGOD 10 00000000	149	ILMN_1786426	19	rs5762235	22	27925288		rs8106959	19	36219525	TMEM149	6.79				
INAN_1756426 19 restriction 19 restrictio	ILANI, 1766422 19 18001090 10 3921022 FARRILIO 181401090 10 30474310 181401090 10 3021022 FARRILIO 181401090 10 30	149	ILMN_1786426	13	rs6090518	50	45207005		rs8106959	19	36219525	TMEM149	11.09	0.76	:	1	
HANALITYSISTER 19 185100820 19 3021022 TARRILIO 110877501 1288891040 8 9 9 9 9 9 9 9 9 9	ILINA 17766122 15 1510106200 19 30210020 17 17101020 19 1510106200 19 30210020 10 30210020 10 30210020 10 30210020 10 30210020 10 30210020 10 30210020 10 30210020 10 30210020 10 30	49	ILMN_1786426	13	rs807491	61	36268923	SNX26	rs7254601	61	36147315	TMEM149	12.16	81.55	45.78	145.78	0.122
INVALIDATION 1	ILAN 17766420 10 18106200 10 36210620 1 181064610 1 181064620 1 18106620	94.	ILMIN_1786426	6 6	rs&106959	5 5	36219525	TMEM149	rs1081889	01	1990259		0.17	1.55	3.09	0.00	
ILINALIZAGIZACIA 1	IMAN_1786426 19 18100090 19 304210025 TMEML149 15150258 12 12888576 19 18100090 19 304210025 TMEML149 15150258 14 4 50420258 15 50 50 50 50 50 50 50	49	ILMN 1786426	61	rs8106959	61	36219525	TMEM149	rs10937361	0.00	188359436		0.00	3.61	0.00	200,00	
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ILANIA 17864456 19 1881000505 19 30210502 TAREMIA 178245148 13377543 13377543 1301000505 19 30210502 TAREMIA 122531408 13 177102273 13 13 13 13 13 13 13	ILANIA 1786426 19 seltiologo 19 30219025 THEM 14 14701972 2 4 5 5 5 5 5 5 5 5 5	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs1843357	œ	13822381		6.21	3.72	3.33	6.00	
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ILMN.1764426 19 sels106050 19 30210525 TMEN149 ser71721 11 117756426 19 sels106050 19 30210525 TMEN149 ser71724 11 sels106050 19 30210525 TMEN149 ser71724 19 sels106050 19 30210525 TMEN149 sels106050 10 30210525 T	ILMN.1786426 19 rs8100999 19 36219522 TMEM449 rs477124 15 171792273 5 5 9 0.99 0.39	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs2539000	<u>-</u>	147619772		6.70	1.57	1.52	2.27	
ILMN.1764426 19 me8100000 19 30510055 TMEM149 me771228 11 129050460 8.85 8.55	ILANN-1766426 19 rest	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs2731711	ю	171792273		5.92	0.19	0.33	0.19	
ILANIA 1786426 19 rest	ILANN.1786426 19 ras106650 19 36210525 TMEM149 rec020582 6 161889374 8 55 5 5 5 5 5 5 5	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs471728	11	129595460		8.89	0.90	3.62	3.51	
ILANI 1786426 19 ms8100950 19 36219252 TMEM149 ms6202832 19 18627240 19 186219252 TMEM149 ms8100950 19 36219252 TMEM149 ms713338 19 124285645 19 ms8100950 19 36219252 TMEM149 ms710392 19 124285450 19 ms8100950 19 36219252 TMEM149 ms7100950 10 ms7	ILANN 17786426 19 rest 100999 19 392119525 TMEMM449 reg 20136328 1 1 1 1 1 1 1 1 1	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs6718480	2	233879066		8.55	3.31	5.15	7.36	
ILIANI 17766426 19 resilucione	ILMN 17766426 19 rest 10699 19 36219525 TMEM149 rest 107404 1 36219525 TMEM149 rest 107404 1 40 0.07 3.14 ILMN 17766426 19 rest 10699 19 36219525 TMEM149 rest 104940 1 242864942 6.02 0.07 3.14 ILMN 1776842 11 rest 20406 13 36219525 TMEM149 rest 40926 1 242864942 6.00 0.07 3.14 ILMN 1776842 11 rest 20406 1 rest 20406 1 26224927 1 1 0.0	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs6926382	9	161683974		5.80	3.06	8.80	10.72	
LIANIATTROGAZE 19 rest106999 19 33219255 TMEMI49 rest10400 1 242888492 3 6.22 3.86 6.90 9 2.0 ILIANIATTROGAZE 1 rest24056 13 32289025 TMEMI49 rest24025 1 22682405 3 34.90 6.44 0.10 5.75 4.47 ILIANIATTROGASELI 7 rest24056 13 7.2890005 TMEMIA 5.60 0.01 0.07 0.07 ILIANIATROGASELI 7 rest2405723 1 rest240576 1 7.2890005 7.2890005 7.2890005 7.2890005 7.2890006 <td>LMN_1786426 19 R82109255 TMEM149 reg109428 13 214789429 6.24 3.56 6.57 LMN_1786456 19 res1009559 19 36219025 TMEM149 reg109428 13 21478942 6 0.10 0.10 0.10 LMN_1786469 19 res104868 13 7289003 TMEM149 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 1 reg104847 8 0.10 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12</td> <td>149</td> <td>ILMN_1786426</td> <td>19</td> <td>rs8106959</td> <td>19</td> <td>36219525</td> <td>TMEM149</td> <td>rs7213338</td> <td>17</td> <td>80357420</td> <td></td> <td>5.49</td> <td>0.07</td> <td>3.14</td> <td>2.10</td> <td></td>	LMN_1786426 19 R82109255 TMEM149 reg109428 13 214789429 6.24 3.56 6.57 LMN_1786456 19 res1009559 19 36219025 TMEM149 reg109428 13 21478942 6 0.10 0.10 0.10 LMN_1786469 19 res104868 13 7289003 TMEM149 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 7 reg1048831 1 reg104847 8 0.10 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12 0.11 0.12	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs7213338	17	80357420		5.49	0.07	3.14	2.10	
LIANI T796426 19 res100999 19 res201095 11 res201095 10 res201095	LINN 1781045 19 FASTOGOGO TREMI149 FASTOGOGO TRABEL AND TABLES 13 72800066 13 72800062 TRABEL AND TABLES 13 72800066 13 72800062 TRABEL 13 72800076 14 0.10 5.75 LINN 170648 11 1155841 7 12800243 11 2606426 1 160846 1 0.10 0.11 </td <td>149</td> <td>ILMN_1786426</td> <td>19</td> <td>rs8106959</td> <td>19</td> <td>36219525</td> <td>TMEM149</td> <td>rs914940</td> <td>1</td> <td>242889492</td> <td></td> <td>6.22</td> <td>3.36</td> <td>96.9</td> <td>9.20</td> <td></td>	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs914940	1	242889492		6.22	3.36	96.9	9.20	
LIMALITORAGE 1 PLAGAGE 1 20002733 THERMORA 5.00 0.44 0.12 0.32 LIMALITORAGE 1 Initidates 2 2 2 0 <th< td=""><td>LINN_1770649 I mil22408 13 750007233 TNEM66A 5.60 0.64 0.12 LINN_1770649 I mil22408 13 58058246 13 56007233 7.00 18.00 0.64 0.12 LINN_188811 7 ris55746 9 4859303 ris104863 7 12869948 RRF6 5.61 0.01 0.01 LINN_188811 7 ris157704 9 22287303 11 18887887 7 18.00 0.40 0.17 LINN_188466 11 ris175840 10 7758194 RAPAPC ris175840 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194</td><td>149</td><td>ILMN_1786426</td><td>19</td><td>rs8106959</td><td>19</td><td>36219525</td><td>TMEM149</td><td>rs9509428</td><td>13</td><td>21473952</td><td></td><td>9.44</td><td>0.10</td><td>5.75</td><td>4.47</td><td></td></th<>	LINN_1770649 I mil22408 13 750007233 TNEM66A 5.60 0.64 0.12 LINN_1770649 I mil22408 13 58058246 13 56007233 7.00 18.00 0.64 0.12 LINN_188811 7 ris55746 9 4859303 ris104863 7 12869948 RRF6 5.61 0.01 0.01 LINN_188811 7 ris157704 9 22287303 11 18887887 7 18.00 0.40 0.17 LINN_188466 11 ris175840 10 7758194 RAPAPC ris175840 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194 10 7758194	149	ILMN_1786426	19	rs8106959	19	36219525	TMEM149	rs9509428	13	21473952		9.44	0.10	5.75	4.47	
ILMN. 1708482	LMN 1709483 11 risiday715 19 560503246 risiday715 10 560503246 11 risiday715 10 4859333 risiday715 10 48593348 IRF5 5.79 0.04 0.15 ILMN 188811 7 risiday73 7 23528927 7 128693948 IRF5 5.52 1.03 0.13 ILMN 188811 7 risiday60 11 risiday60 13 risiday62 14 risiday62 14 risiday62 14 risiday62 14 risiday62 15 risiday62 15 risiday62 15 risiday62 15 risiday62 15 risiday62 15 risiday62 10 risiday62 14 risiday62 15 risiday62 14 risiday	63A	ILMN_1719649	П	rs1254086	13	72890603		rs4149226	1	226027323	TMEM63A	5.60				
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LMN.137043 7 1199733 2 22287303 ra11770192 7 128498348 IRF5 5.52 10.3 0.17 0.02 LMN.137043 7 1199783 1 130531675 ra11770192 7 128498348 IRF5 5.52 10.3 0.07 0.02 LMN.137043 11 11278760 13 130531675 13 13185744 0 22 0.03 0.01 0.05 LMN.227039 19 17758194 TRAPPC5 11 118887887 TRAPPC4 5.57 0.03 0.07 0.08 LMN.227039 19 17758194 TRAPPC5 11765890 1 273219791 0.03 0.03 0.04 0.05 LMN.227039 19 17758194 TRAPPC5 17758194 TRAPPC5 17758194 TRAPPC5 17758194 TRAPPC5 17758194 17758194 17758194 17758194 17758194 17758194 17758194 17758194 17758194 17758194 17758194 <	ILMN.1632811 7 resignosts 7 2 2 2 3		ILMN_1683811	-1	rs1537146	6	4859303		rs10488630	7	128593948	IRF5	5.61	0.11	0.15	0.07	
LMN_1213043 7 ray775042 7 23428285 11 118887887 TRAPPCA 5.61 0.28 0.40 0.29 LMN_1214450 11 rai775870 13 13018317 TRAPPCA rai3916881 11 118887887 TRAPPCA 5.61 0.28 0.40 0.29 LMN_2272639 19 rai775849 19 7758194 TRAPPCA 5.105000 0.37 0.21 1.60 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.37 0.21 0.01 0.37 0.01 0.37 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.37 0.01 0.37 0.01 0.37 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.36 0.01 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01	ILMN.1731043 7 re3775043 7 re3775043 7 re3775043 7 re3775043 7 re3775043 7 re3775043 7 re3775572 7 re3775554 1 re3775554 1 re3775554 1 re377554 1 re3775544 1 re3775544 1		ILMN_1683811	-1	rs199793	20	22287303		rs10488630	-1	128593948	IRF5	5.52	1.03	0.17	0.62	
ILMN L814650 11 re1278650 13 133334675 re3218681 11 118887887 TRAPPCS re3216881 11 118887887 TRAPPCS re3216881 11 118887887 TRAPPCS re3216881 11 118887887 TRAPPCS re3216881 11 118887887 TRAPPCS re3216891 11 118887887 TRAPPCS re3216891 11 118887887 TRAPPCS 0.32 0.03 0.01 0.05 ILMN 2272689 19 re3716840 19 7758194 TRAPPCS re13239791 6.54 0.02 0.03 0.04 0.05 ILMN 2272689 19 re3716840 19 7758194 TRAPPCS re3233971 6.54 0.02 0.04 0.05 ILMN 2272689 19 re3716840 19 7758194 TRAPPCS re320491 2.34 0.04 0.05 0.04 0.05 ILMN 2272689 19 re3716840 19 7758194 TRAPPCS re760096 17 7.4466000	ILMN_1814660 11 rs1278760 13 rs137887687 13 rs137887687 13 rs13788769 13 rs1375840 13 rs13183467 rs1319840 13 rs1375840 13 rs137544 13 rs137549 14 rs137544 14 rs137544 14 rs137544 15 14 rs1375840 13 rs137544 14 rs137544 14 rs137544 14 rs137544 14 rs1375840 15 rs1375840 15 rs1375840 15 rs1375840 15 rs1375840 15 rs1375840 15 rs1375840 16 rs1375840 17 rs1375840 14 rs1375840 15 rs138550 15 rs1375840 15 rs1385550 15 rs1375840 17 rs1		ILMN_1731043	-1	rs7776572	-1	23528927		rs11770192	-1	23498358		8.23	3.19	1.89	4.09	0.031
ILMN 2372639 19 F7788194 TRAPPCS 11 1888787 TRAPPCA 5.52 0.93 0.01 0.36 ILMN 2372639 19 rs17159840 19 7778194 TRAPPCS rs1203095 8 13022957 7.79 0.21 1.00 3.36 ILMN 2372639 19 rs17159840 19 7778194 TRAPPCS rs1329791 6 1	ILMN 2372639 11 Fail 1759840 1 Fail 18887887 TRAPPC4 5.52 0.93 0.01 ILMN 2372639 19 rail 1759840 19 7758194 TRAPPC5 rail 0500064 1 118887887 TRAPPC4 5.92 0.37 0.01 ILMN 2372639 19 rail 159840 19 7758194 TRAPPC5 rail 375744 6 1.00 0.37 0.03 0.01 ILMN 2372639 19 rail 159840 19 7758194 TRAPPC5 rail 38229 1 42232971 0.03 0.03 0.04 ILMN 2372639 19 rail 159840 19 7758194 TRAPPC5 rail 38229 1 7546442 0.03 0.04 0.65 ILMN 2372639 19 rail 159840 19 7758194 TRAPPC5 rail 38329 1 754940 0.04 0.65 ILMN 2372639 19 rail 159840 19 7758194 TRAPPC5 rail 3826638 1 75494442 7.58 0	,C4	ILMN_1814650	11	rs1278760	13	113531675		rs3916581	11	118887887	TRAPPC4	5.61	0.28	0.40	0.29	
ILMN 2372639 19 7758194 TRAPPCS residences 5 7 0.21 1.00 1.07 ILMN 2372639 19 residences 19 7758194 TRAPPCS residences 6 92 0.37 0.58 0.08 ILMN 2372639 19 residences 19 7758194 TRAPPCS residences 0.2 0.17 0.0	ILMN 2372639 19 restricted 19 7758194 TRAPPCS restricted 5 166970604 5 166970604 6 166470604 6 166470604 10 17 10 10 1	,C4	ILMN_1814650	11	rs1793823	11	131018917		rs3916581	11	118887887	TRAPPC4	5.52	0.93	0.01	0.36	12.131
LIMN.2372039 19 778194 TRAPPCS 1817153890 19 778194 TRAPPCS 181753995 0.37 0.37 0.37 0.08 ILMN.2372039 19 1778194 T788194 TRAPPCS 18137514 6.13 0.63 0.47 0.08 ILMN.2372039 19 181715840 19 7778194 TRAPPCS 181376345 1 6.51 0.53 0.47 0.08 ILMN.2372039 19 181715840 19 7758194 TRAPPCS 18763465 1 6.51 0.50 0.36 0.47 0.68 ILMN.2372039 19 1817158840 19 7758194 TRAPPCS 1758194 TRAPPCS 1 9947811 6.51 0.20 0.36 0.43 0.68 0.21 0.22 0.16 0.22 0.16 0.22 0.21 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22 0.22	LIMN 237039 19 7758194 TRAPPCS 18102099 8 13202297 7.59 0.37 0.37 LIMN 237039 19 re17159840 19 7758194 TRAPPCS re1303299 1 24232773 7.79 0.23 LIMN 237039 19 re17159840 19 7758194 TRAPPCS re1303299 1 24232773 6.31 0.53 0.47 LIMN 237039 19 re17159840 19 7758194 TRAPPCS re1303299 1 6.31 0.50 0.38 LIMN 237039 19 re17159840 19 7758194 TRAPPCS re780395 17 6.31 0.50 0.38 LIMN 237039 19 re17159840 19 7758194 TRAPPCS re780305 17 14690026 6.31 0.36 0.33 LIMN 237039 19 re17159840 19 77758194 TRAPPCS re780305 17 14690026 7.73 0.38 LIMN 2370639 19	j C	ILMIN-2372639	61	rs17159840	13	7758194	TRAPPCS	rs10059004	ဂ	166970604		5.97	0.21	1.60	1.07	
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$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	ILMN 2372639 19 7758194 TRAPPC5 re17159840 19 7758194 TRAPPC5 re17159840 1 7758194 TRAPPC5 re17159840 1 7758194 TRAPPC5 re17159840 1 7758194 TRAPPC5 re17159840 19 7758194 TRAPPC5 re17159840 19 7758194 TRAPPC5 re7780359 17 7758194 TRAPPC5 re7780359 17 7758194 TRAPPC5 re7780359 17 7758194 <	9 5	ILMIN_2372639	61.	rs1/159840	1.9	7758194	TRAPPOS	rs1375714	٥٠	156404902		6.79	0.12	0.18	0.08	
LIMN 2372639 19 Fill 198940 19 7788194 TRAPPCS Figl 178940 19 7788194 TRAPPCS Figl 178940 19 7788194 TRAPPCS Figl 1884328 17 6.05 0.21 0.50 <t< td=""><td>ILMN 2372639 19 7788194 TRAPPCS references 1 7788194 7788194 TRAPPCS references 1 7788194 <</td><td>0 1</td><td>ILMIN_2372639</td><td>2 5</td><td>rs17159840</td><td>5 5</td><td>7758194</td><td>TRAPPCS</td><td>rs1393299</td><td>٦ -</td><td>242329791</td><td></td><td>0.43</td><td>0.03</td><td>0.47</td><td>0.58</td><td>i i</td></t<>	ILMN 2372639 19 7788194 TRAPPCS references 1 7788194 7788194 TRAPPCS references 1 7788194 <	0 1	ILMIN_2372639	2 5	rs17159840	5 5	7758194	TRAPPCS	rs1393299	٦ -	242329791		0.43	0.03	0.47	0.58	i i
ILMN 2372639 19 ***17159840 19 ***1758194 TRAPPCS ****173362 1 ****17159840 19 ****1758194 TRAPPCS *****17159840 19 ******17159840 19 ************************************	ILMN 2372639 19 riflogate 1758194 TRAPPC5 riflogate 1 riflogate<	3 5	ILMIN-2372639	2 -	rs17159840	2 -	7750104	TRAPPOS	rs17763599	1 0	2309415		0.38	0.21	0.24	0.10	0.389
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ILMN 2372639 19 rs37159840 19 rs778194 TRAPPC5 rs350538 14 55439550 673 0.24 0.07 0.08 ILMN 2372639 19 rs380708 22404854 rs47159840 19 7758194 TRAPPC5 7.73 0.85 0.78 1.01 ILMN 2372639 19 rs8016995 21 45128454 rs41719840 19 7758194 TRAPPC5 7.73 0.85 0.78 1.01 ILMN 2372639 19 rs724264 19 7762978 rs1219140 16 3.048765 7.74 0.14 0.05 0.05 ILMN 2372639 19 rs724264 19 7762978 rs1283778 1 7.41 0.14 0.26 0.13 ILMN 1272639 19 rs724264 19 7762978 rs283577 4 12 8744938 1 10 1 1 1 1 1 1 1 1 1 1 1 1 1	ILMN 2372639 19 rs78159840 19 7758194 TRAPPC5 rs765638 14 85439550 TAPP 7758194 TRAPPC5 7758194 TRAPPC5 7758 0.24 0.07 ILMN 2372639 19 rs8040614 2 22740855 11272861 19 7758194 TRAPPC5 7.75 0.85 0.78 ILMN 2372639 19 rs7246264 19 7762978 rs17159840 19 7778194 TRAPPC5 7.73 0.85 0.78 ILMN 2372639 19 rs7246264 19 7762978 rs10251440 16 30408765 7.74 0.14 0.26 ILMN 2372639 19 rs7246264 19 7762978 rs10251440 16 30408765 7.74 0.14 0.26 ILMN 2372639 19 rs7246264 19 7762978 rs10251440 16 30408765 7.41 0.14 0.26 ILMN 2372639 19 rs7762978 rs1026422 10 10 1	Q5	ILMN_2372639	19	rs17159840	19	7758194	TRAPPC5	rs7800935	7	146690926		6.27	0.15	0.33	0.16	
ILMN 2372639 19 res000995 2 2740855 res17198840 19 7758194 TRAPPC5 7.58 7.58 1.01 ILMN 2372639 19 res0010995 2.1 45122464 19 7758194 TRAPPC5 7.58 0.55 0.55 0.56 ILMN 2372639 19 res04054 19 7762978 res1718840 19 7768194 TRAPPC5 8.10 0.51 0.55 0.56 ILMN 2372639 19 res7246264 19 7762978 res12921440 16 3040876 7.34 0.14 0.26 0.13 ILMN 2372639 19 res7246264 19 7762978 res12921440 16 3040876 7.34 0.14 0.26 0.13 ILMN 2372639 19 res7246264 19 7762978 res12921440 16 3040876 7.34 0.14 0.26 0.13 ILMN 1088231 6 res104569 1 7.65 0.08 0.09 0.09	ILMN 2372639 19 re380708 22 2740855 re17159840 19 7758194 TRAPPC5 7.58 0.58 0.78 ILMN 23722639 19 re3040514 20 11272861 re17159840 19 7758194 TRAPPC5 7.73 0.85 0.78 ILMN 23722639 19 re7246264 19 7762978 re17159840 19 7758194 TRAPPC5 8.10 0.51 0.55 ILMN 2372639 19 re7246264 19 7762978 re12291440 1 7758194 TRAPPC5 8.10 0.51 0.56 ILMN 2372639 19 re7246264 19 7762978 re12291440 1 7762978 7762978 7762978 7762978 7762978 7762978 7762978 7762978 7762978 7762978 7762978 7762977 7762977 7741 0.36 0.90 ILMN 168231 6 re2245774 6 41264577 TREM1 5.42 0.11 0.25 ILMN 178561<	Ö5	ILMN_2372639	19	rs17159840	19	7758194	TRAPPC5	rs856638	14	85439550		6.73	0.24	0.07	80.0	
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ILMN_2372639 19 refold 50.4 20 11272861 res/172863 8.10 0.55 0.56	ILMN 12372639 19 rsf246264 19 7762978 rs1073672 rs10736340 19 77762978 rs1073672 rs10736340 19 rs1073672 rs10736340 19 rs1073672 rs10736340 19 rs1073672 rs10736340 19 rs1073672 rs1036264 19 7762978 rs10736264 19 7762978 rs1036264 19 7762978 rs1036264 19 7762978 rs1036264 19 7762978 rs1036264 10 rs103624 10 rs1036	Ç	ILMN_2372639	13	rs3916995	21	45128454		rs17159840	19	7758194	TRAPPC5	7.73	0.85	0.78	1.01	
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LLMN_2372639 19 F7724274 19 T762374 16 30408765 7.34 0.14 0.26 0.13 LLMN_2372639 19 F87246264 19 T762378 18887778 9 13463308 RAPGEF1 7.34 0.14 0.26 0.13 LLMN_2372639 19 F87246264 19 7762378 18887778 114633088 RAPGEF1 7.41 0.08 0.09 0.06 LLMN_188231 6 F812412964 10 108256422 183393771 6 41264577 TREMI 5.92 1.20 0.11 0.25 0.01 LLMN_188231 6 F825257180 7 158804316 F8264369 TREMI 5.92 1.20 1.23 1.69 LLMN_178560 10 F82573079 T8273079 T8273079 T87AN1 6 0.04 0.01 0.01 0.01 0.06 LLMN_178560 11 F81088738 11 27194634 F81074856 10 27273079 <	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Q2	ILMN_2372639	19	rs7246264	19	7762978		rs10179572	C1 ;	228504503		6.71	0.14	0.02	0.02	
ILMN_12372639 19 Fi274264 19 7762278 Fi2863344 19 7762278 Fi2863364 10 7762278 Fi2863364 10 762278 Fi2863271 10 762278 Fi2863271 10 762278 Fi2863271 10 762278 Fi2863278 10 762278 Fi2863271 10 762278 Fi2863278 10 762278 Fi2863278 10 762278 Fi286328 10 762278 Fi286328 10 762278 Fi286328 10 762278	ILMN 1282316 19 7702974 19 7702975 12 18738577 19 7702975 19		ILMIN_2372639	61	rs7246264	61	7762978		rs12921440	16	30408765	-	7.34	0.14	0.26	0.13	
ILMN 1868231 6 res1242964 19 res02395771 6 41264577 TREMI 7.41 0.30 0.10 0	ILMN.1688231 5 12 12 12 12 12 12 12		ILMIN_2372639	61	rs/246264	61	7762978		rs1887778	n o	134635088	KAPGEFI	60.7	0.08	0.86	0.40	
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Table S1 - continued from previous page

a Phenotypes are expression levels of RefSeq Genes
Dilumina probe ID used to measure gene expression
Physical SNP position in base pairs (HG19)
d RefSeq Gene ID of gene expression level that is influenced by the SNP (BSGS discovery dataset, significance threshold = 1.29 × 10⁻¹¹)
Interaction - log₁₀ p-value from discovery dataset
Interaction - log₁₀ p-value from meta analysis of replication datasets on the statement of the

Table S2: Estimation of additive and non-additive variance components from pedigree information Taken from previous analysis in Powell et al 2013^{21}

		Additi	ve	Non-add	itive
Gene	Probe	Variance	s.e.	Variance	s.e.
NAPRT1	ILMN_1710752	0.37	0.03	0.14	0.05
TMEM149	$ILMN_1786426$	0.41	0.04	0.09	0.04
MBNL1	$ILMN_2313158$	0.18	0.03	0.11	0.04
TRAPPC5	$ILMN_2372639$	0.32	0.04	0.13	0.05
CAST	$ILMN_1717234$	0.31	0.03	0.10	0.04

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