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 examples have been reported in other species, 6 few convincing examples with independent replication 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 $(p < 2.91 \times 10^{-16})$. Replication of these signals in two independent data sets^{11,12} showed both concordance of direction of epistatic effects $(p = 5.56 \times 10^{-31})$ and enrichment of interaction p-values, with 30 being significant at a conservative threshold of p < 0.05/434. There was evidence of functional enrichment for the interacting SNPs, for instance 44 of the genetic interactions are located within 5Mb of regions of known physical 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 trans-acting 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 natural genetic polymorphisms interacting to influence human traits.

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. He are to date, though its contribution to phenotypic variance is frequently the subject of debate, here is little empirical exploration of the role that epistasis plays in the architecture of complex traits in humans. Beyond the prism of human association studies there is evidence for epistasis, not only at the molecular scale from artificially induced mutations but also at the evolutionary scale in fitness adaptation. In and speciation.

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, thus many genetic effects are relatively large.²¹ 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 used a two stage approach to identify genetic interactions. First, we exhaustively test every pair of SNPs for pairwise effects against each of 7339 expression traits in peripheral blood (5% significance threshold $p < 2.91 \times 10^{-16}$, Methods). Second, we filtered the SNP pairs from stage 1 on LD and genotype class counts, and tested the remaining pairwise effects for significant interaction terms and used a Bonferroni correction for multiple testing (estimated type 1 error rate $\alpha \approx 0.07$, Methods, Supplementary Figure S1). Using this design we identified 501 putative genetic interactions influencing the expression levels of 238 genes (Supplementary Table S1). 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 (5\% significance threshold p < 0.05/434, Table 1). To quantify the similarity of GP maps between the independent datasets (Figure 1) we decomposed the genetic effects of each of the SNP pairs into orthogonal additive, dominance and epistatic effects (A1, A2, D1, D2, $A \times A$, $A \times D$, $D \times A$, $D \times D$) and tested for concordance of the sign of the most signicant effect (Supplementary Table S3, Methods). Sign concordance between the discovery and both replication datasets was observed in 22 out of the 30 significantly replicated interactions (expected value = 7.5 under the null hypothesis of no interactions, $p = 3.76 \times 10^{-8}$).

In addition, using the meta analysis from the replication samples only, we observed that 316 of the remaining 404 discovery SNP pairs had replication interaction p-values more extreme than the 2.5% confidence interval of the quantile-quantile plot against the null hypothesis of no interactions ($p << 1.0 \times 10^{-16}$, Figure 2 and Supplementary Figure S2). Concordance of the directions

tion of the effect of the largest variance component was also highly significant $(p = 5.71 \times 10^{-31})$, Supplementary Table S3). The congruence of the epistatic networks in discovery and replication datasets is shown in Figure 3, 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 20 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 (Supplementary Figure S6). 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 (Supplementary Figure S7), 17,18 and for higher power terms of LD r the sampling variance increases (Methods, Supplementary Figure S8). 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, 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 association [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 (i.e. $A \times A$, $A \times D$, $D \times A$, $D \times D$) are simply convenient orthogonal parameterisations of a two locus model, and are not intended to model biological function.

Of the discovery interactions, 47 were *cis-cis* acting (both SNPs were on the same chromosome as the expression gene, median distance between interacting SNPs is 1.83Mb), 441 were *cis-trans*-acting, and 13 were *trans-trans*-acting. We observed a wide range of significant GP maps (Figure 1) 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 S9). Each of these interactions has evidence for replication in at least one dataset and six are significantly replicated at the Bonferroni level (Supplementary Figure S3). We see similar epistatic networks involving multiple (eight or more) *trans*-acting SNPs for other gene expresson levels too, for example TMEM149 (Supplementary Figure S10), NAPRT1 (Supplementary Figure S11), TRAPPC5 (Supple-

mentary Figure S12), and CAST (Supplementary Figure S13). 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,tri-methylation (H3K4me3) chromatin marks, in 34 cell types 26 (Supplementary Figure S5). There was significant enrichment for cis-acting SNPs in haematopoietic cell types only ($p<1\times10^{-4}$ 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 tissue specificity is provided by the cis SNPs. There is also enrichment for cis-SNPs to be localised in regions with regulatory genomic features as measured by chromatin states 27 (Supplementary Figure S4).

We also demonstrate physical organisation of interacting loci within the cell, 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 5Mb ($p<1.8\times10^{-10}$), (Supplementary Figure S14). 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 is 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. Ideally one would approach this question from a whole genome perspective 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. 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. 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 relative 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. Each individual had gene expression levels measured in peripheral blood at 47,323 probes. Only the probes that passed quality control and had significant expression in > 90% of individuals were used in the analysis (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 sentinel 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 = 1240) and the Estonian Genome Centre University of the University of Tartu (EGCUT) dataset (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

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

	1	O				1	
	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

Figures

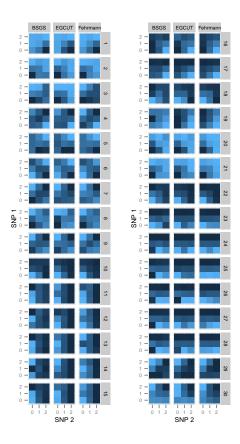


Figure 1: Replication of GP maps in two independent populations The GP maps for each epistatic interaction that is significant at the Bonferroni level in both replication datasets are shown. Each GP map consists of nine tiles where each tile represents the expression level for that two-locus genotype 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 dataset. 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.

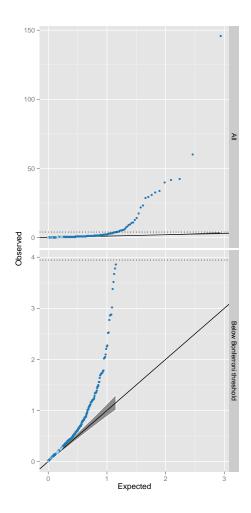


Figure 2: \mathbf{Q} - \mathbf{Q} plots of interaction p-values from replication datasets. The top panel shows all 434 discovery SNPs that were tested for interactions. Observed p-values (y-axis, $-\log_{10}$ scale) are plotted against the expected p-values (x-axis, $-\log_{10}$ scale). The multiple 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.

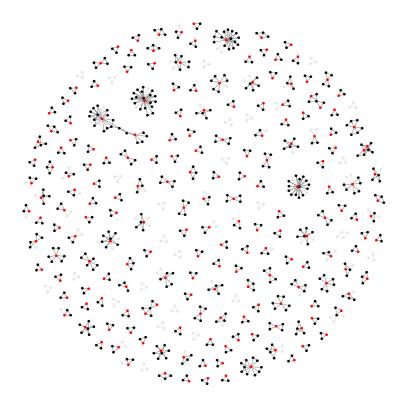


Figure 3: Discovery and replication of epistatic networks All 434 putative genetic interactions (edges) with data common to discovery and replication sets is shown, where black nodes represent SNPs and red nodes represent traits (gene expression probes). Three hundred and forty-five interactions had p-values exceeding the 2.5% confidence interval following meta analysis of the replication data 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.

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Supplementary Figures

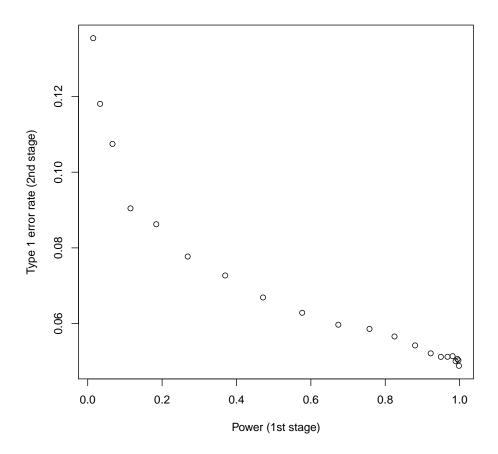


Figure S1: Type 1 error rate of two stage design In stage 1 SNPs are tested for full genetic effects (8 d.f.) and those that surpass a threshold for multiple testing are then tested for significant interaction terms in stage 2. These interaction p-values are then adjusted (Bonferroni) for the total number of tests that passed stage 1. The type 1 error rate of this two stage design is dependent on the power, which is not known empirically.

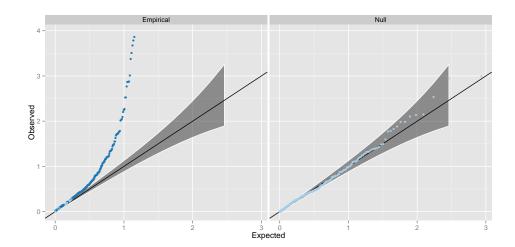


Figure S2: Q-Q plots of interaction p-values from replication datasets, excluding the 30 points significant at the Bonferroni level The right panel (Null) shows the interaction p-values from a meta analysis across two independent datasets on 434 randomly drawn SNP pairs. The left panel (Empirical) shows 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 2.

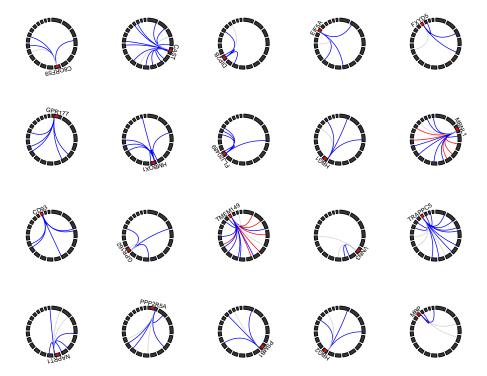


Figure S3: Gene expression traits with four or more genetic interactions Circle plots represent the genomic positions for SNPs (linking lines) and expression probes (red points). Chromosomes are represented by black blocks and ordered from 1 to 22 clockwise, starting from the top. Grey lines represent no evidence for replication, blue lines denote interactions that are outside the 97.5% confidence interval or the Q-Q plot (Figure 2), and red lines denote replication at the Bonferroni correction level. Most interactions are characterised as being *cis-trans* to the expression probe.



Figure S4: Location of SNPs relative to genomic features We used chromatin segmentation 27 as a method for labelling 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, E CTCF enriched element, E Predicted weak enhancer or open chromatin cis regulatory element, E Predicted promoter flanking region, E Predicted promoter region including transcriptional start site, E Predicted transcribed region, E Predicted Repressed or Low Activity region

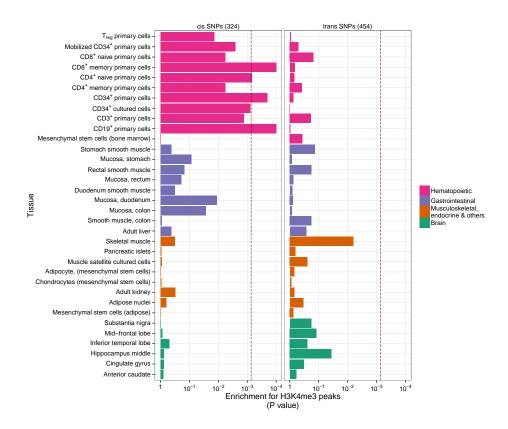


Figure S5: Tissue specific enrichment of SNPs in transcriptionally active regions The locations of transcriptional activity can be predicted by chromatin marks, assayed by H3K4me3. Enrichment p-values are calculated using permutation analysis for 34 different cell types (y-axis) in four tissue types (Rows of boxes). The dotted red line denotes significance (Bonferroni correction for 34 cell types, x-axis). There is enrichment for cis-acting SNPs in Haematopoietic tissue types only. Trans-acting SNPs have no tissue specificity.

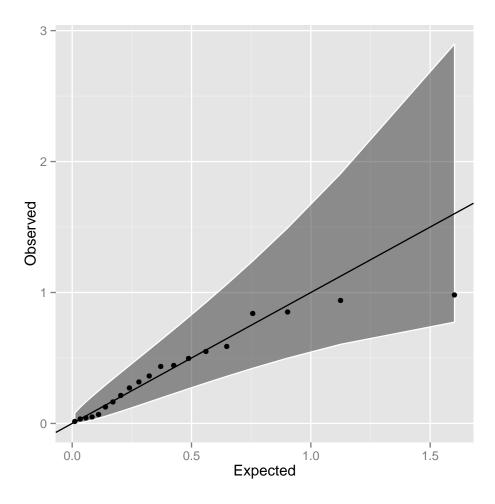


Figure S6: Q-Q plot of interaction p-values in the CDHWB dataset Twenty of the 501 discovery SNP pairs passed filtering in the CDHWB dataset (mainly due to small sample size). There is no evidence for enrichment of interaction terms, most likely due to insufficient power given the limited sample size.

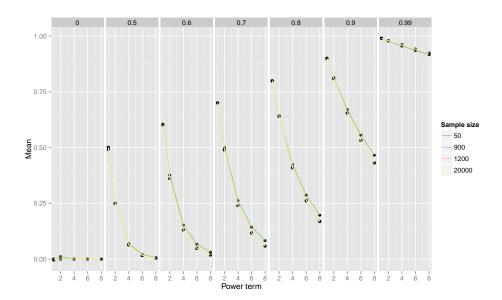


Figure S7: Sampling mean for different power terms of population r values Power of detection and replication of epistatic signals depends not on r^2 between causal variants and observed SNPs, but on r^4, r^6, r^8 . For a given a population value of LD r (columns of plots), plotted is the sample mean (y-axis) of \hat{r} , \hat{r}^2 (additive), \hat{r}^4 (dominance, A×A), \hat{r}^6 (A×D), \hat{r}^8 (D×D) (x-axis) for different sample sizes (coloured lines). As true r reduces the statistical power to detect epistatic variants drops dramatically under the assumption that statistical power is proportional to higher moments of r.

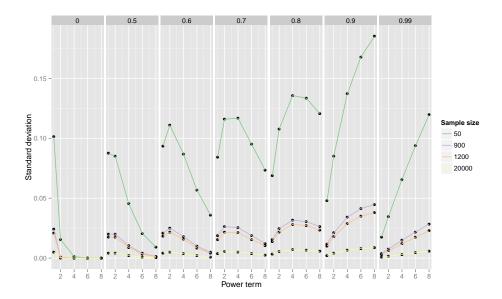


Figure S8: Sampling standard deviation for different power terms of population r values Power of detection and replication of epistatic signals depends not on r^2 between causal variants and observed SNPs, but on r^4, r^6, r^8 . For a given a population value of LD r (columns of plots), plotted is the sampling standard deviation (y-axis) of \hat{r} , \hat{r}^2 (additive), \hat{r}^4 (dominance, A×A), \hat{r}^6 (A×D), \hat{r}^8 (D×D) (x-axis) for different sample sizes (coloured lines). As the power term of r increases the sampling variance also increases. Supposing that there is sufficiently high r^x in the discovery sample for detection of epistasis, the replication sample is less likely to have similarly high r^x as x increases, leading to an expectation of reduced replication rates.

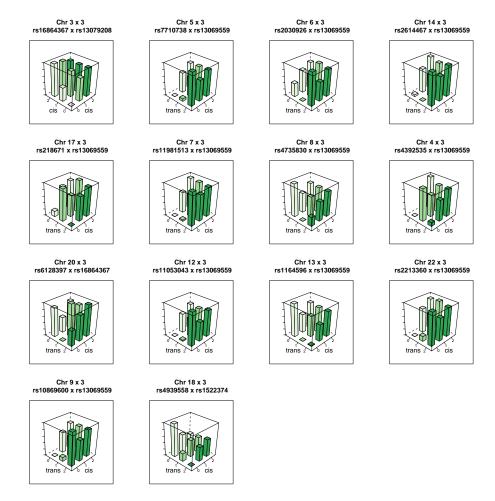


Figure S9: Genotype-phenotype maps for 14 interactions influencing the expression of MBNL1 Each bar represents the mean phenotypic value for individuals in that genotype class. The rs13069559 SNP typically has a *cis*-additive decreasing effect on the expression of MBNL1, but in many of these interactions the *cis* effect is masked when the *trans* SNP is homozygous for the masking allele.



Figure S10: 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 for the masking allele.

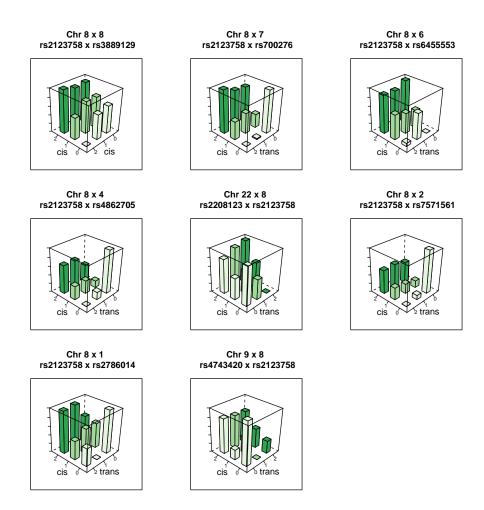


Figure S11: Genotype-phenotype maps for 8 interactions influencing the expression of NAPRT1 Each bar represents the mean phenotypic value for individuals in that genotype class.



Figure S12: Genotype-phenotype maps for 16 interactions influencing the expression of TRAPPC5 Each bar represents the mean phenotypic value for individuals in that genotype class.

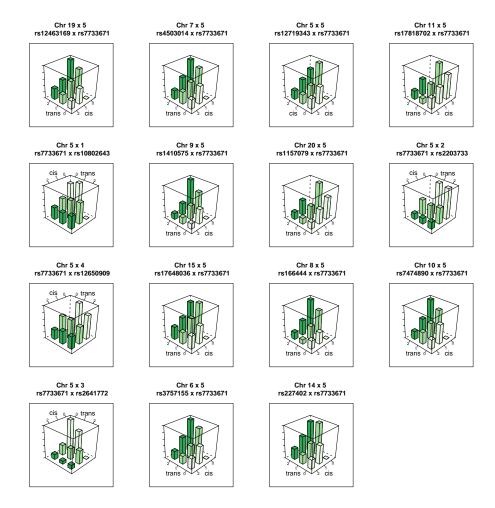


Figure S13: Genotype-phenotype maps for 15 interactions influencing the expression of CAST Each bar represents the mean phenotypic value for individuals in that genotype class.

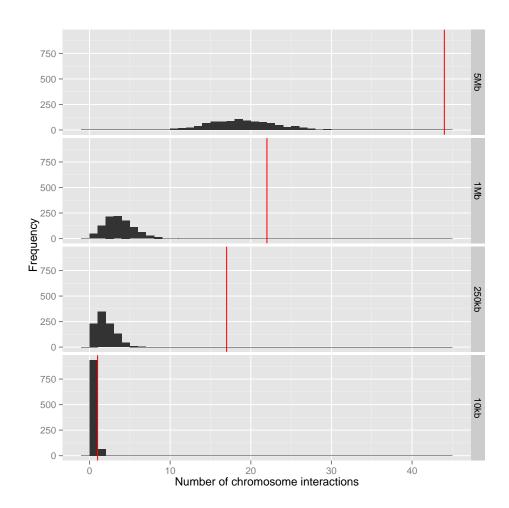


Figure S14: Number of overlaps between chromosome interactions and epistatic interactions Interacting chromosome regions may be a possible mechanism underlying epistatic interactions. The number of epistatic interactions within 20kb, 500kb, 2Mb and 10Mb of known chromosome interacting regions are shown by red vertical lines. The histograms represent the null distribution based on random sampling of 1,000 datasets for each window size.

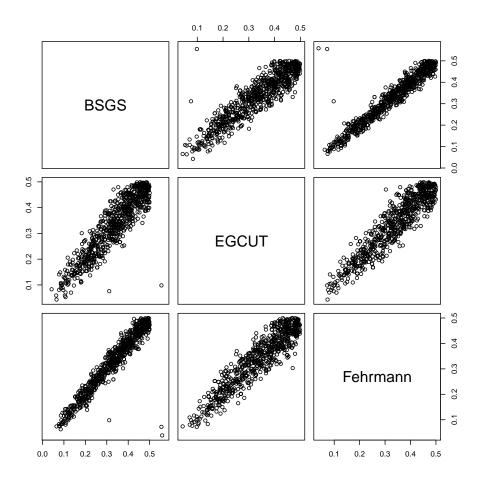


Figure S15: Comparison of allele frequencies for 781 SNPs involved in genetic interactions across independent populations Outliers were removed from the analysis as part of the filtering stage during replication.

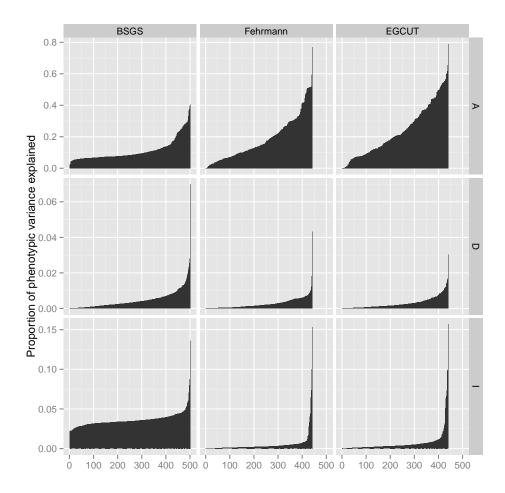


Figure S16: Comparison of variance explained by additive, dominant and epistatic effects from different cohorts How does the estimated variance decomposition change in different cohorts? The proportion of the phenotypic variance that is additive (A), dominant (D), or epistatic (I) for each putative interaction 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.

Supplementary Tables

Table S1: Details on 501 interactions discovered in BSGS dataset

Probe ID D Other ID	rs ID rs3752237 rs3752237 rs9455 rs227664 rs12431896 rs8058066 rs8058066 rs2395095 rs23151512 rs10881585	Chr. 19	Pos/Mbc	Association		,		-					
		19		******	rs ID	CITY:	Pos/Mbc	Association	BSGSe	Fehrmann ¹	EGCUT.	Metag	Distance / Mb
			1047161	ABCA7	rs596183	9	158100199		5.82	0.38^{1}	0.02^{1}	0.09j	
		1 2	1047161	ABCA7	rs914737	10	139522101		5.50	0		1	
		11	108207303	A D C C S	rs4/32202	- 0	72001517		6.10	1.02	1.01	0.83	
		14	78088813	ADCK1	rs4833241	0 4	122933691		2.50	0.36	1.14	0.87	
		16	88462550		rs12431896	14	78088813	ADCK1	6.58	2.04	0.83	2.05	
		10	76446305	ADK	rs10824092	10	75929517		69.9	18.33	21.21	39.82	0.517
		10	51515534	AGAP8	rs2547996	Ю	95174319		6.22				
	_	6	137112421		rs842647	2	61119471		7.15	1.83	1.93	2.88	
		9	29938258	HLA-G	rs1177303	2	61388355	AHSA2	5.45	0.92	0.64	0.94	
		16	57721127		rs13332406	16	53489705	AKTIP	6.91	0.16	0.99	0.57	4.231
	_	16	53536345	AKTIP	rs1362032	7	125543391		5.93	0.71	0.20	0.42	
		16	53536345	AKTIP	rs1473017	4	179323762		6.18	0.27	0.30	0.23	
	rs3760489	17	19581009	ALDH3A2	rs11720112	က	161996349		6.26	0.33	1.37	1.01	
	rs9322855	14	21153299	ANG	rs4866516	IJ	3032625		5.75	0.02	0.20	0.04	
	rs11073891	15	90363995	ANPEP	rs3823523	-	154511163		5.85	0.44	1.09	06.0	
ILMN_1763837 15	rs11073891	15	90363995	ANPEP	rs6846031	4	178019148		6.31	0.47	0.17	0.26	
ILMN_1768867 5	rs6453374	ю	77508159	AP3B1	rs4684443	က	4818792		5.94	0.05			
_		12	105580918	APPL2	rs2769594	6	87918528		5.60	0.80	1.02	1.16	
ILMN_3231952 17	rs12947580	17	75768225		rs8079215	17	44064851	ARL17B	5.96				31.703
ILMN_3231952 17	rs2834541	21	35932619		rs8079215	17	44064851	ARL17B	6.65				
ILMN_3231952 17	_	17	44064851	ARL17B	rs1950646	14	94722497		7.64				
ILMN_3231952 17	rs8079215	17	44064851	ARL17B	rs2197777	12	125831219		6.26				
ILMN_3231952 17	rs8079215	17	44064851	ARL17B	rs2684789	15	99492045		5.98				
	_	17	44064851	ARL17B	rs9834627	က	191203546		5.72				
	_	19	19810050		rs873870	19	19738554		5.30	12.18	3.25	14.23	0.071
	_	22	18213057	BID	rs9804943	12	129906275		5.84	90.0	0.40	0.14	
•••	_	22	18233000		rs10888267	-	248059423		09.9	0.87	0.16	0.20	
	_	11	8886260	C11ORF17	rs6553184	4	189150656		5.66	1.15	0.04	0.54	
	_	16	6259852	0	rs674754	13	46913416	C13ORF18	6.66	0.28	0.28	0.22	
	_	13	46913416	C13ORF18	rs6857876	4 ;	153610164		3.80	0.38	0.50	0.43	
	_	55	37575398		rs4983382	14	105189504	C140RF173	6.02	09.0	0.84	0.85	
	_	15	92276674	0.10	rs4983382	14	105189504	C14ORF173	10.08	0.31	0.28	0.24	
ILMIN_2393450 14	TS4900001	10	19810679	CI4ORF1/3	FSIU/54644	1.	77574400		7.10	0.47	0.34	0.33	
	_	14	77574438		rs10972462	* G	35427324		4.32				
	_	14	77574438		rs6445340	n	63371601		4.40				
ILMN_1804396 14	rs2655991	14	77574438		rs9787151	-1	63179138		4.05				
ILMN_1804396 14	rs4793445	17	70416307		rs2655991	14	77574438		3.85				
	_	22	51151724		rs2655991	14	77574438		4.61				
		61	52083552		rs2655991	41.	77574438	0	4.69	0	i c		
ILMIN_1/4/34/ 1/	rs9907897	17	110577053		rs/405659	1,	00000	CIORFO	0.0	0.03	0.00	91.0	
TI MAN 20027200	F82004020	0 9	10011201		FS223/102	٠,	2002300	CIORFOR	0.90	0.01	0.00	0.13	
0077900 NW:II	1044-04-4	16	25711258		18240002	-	2119833	CIOBES	. r	06.0	0.00	0.37	
11.MN 1795836 21	_	2.5	48052838		rs901964	12	48676038	ZNF641	4 91	0.65	80.0	80.0	
	_	212	48027084		rs11701361	21	47764477		9.42	6.08	16.36	21.67	0.263
		18	45866512		rs286595	ı D	154348552	C5ORF4	5.55	0.72	0.04	0.27	
		13	36577930		rs2896452	00	86102223	CSORF59	5.49	0.29	0.02	0.07	
ILMN_1653205	8 rs12454561	18	31272238		rs2896452	œ	86102223	CSORF59	5.45	0.31			
	_	œ	86102223	CSORF59	rs1004564	4	55242625		7.62	0.38	0.18	0.21	
ILMN_1653205 8	rs7152284	14	52273663		rs2896452	œ	86102223	CSORF59	5.67	2.18	0.07	1.33	

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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 7.00 7.00	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
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	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							
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/alues	ಹ	0.16	0.11	99.0	0.29	0.02	0.04	0.21	0.53	0 13	0.18	59.95	90.0	0.17	0.15	0.02	0.22		0.14	32.60	0.17	0.28	0.11	0.87		0.33	0.24	0.13	000	0.00	0.00	0.0	18.0	0.22	1.50	0.13	09.0	0.23	0.04	0.41	0.16	0.79		0.65	0.23	0.32	0.10	0.12	0.11	0.10	Continued
$-\log_{10} p$ -values	$EGCUT^{f}$	0.33	0.25	0.11	0.70	0.11	0.02	0.17	26.0	0.06	0.64	29.39	0.30	0.41	0.48	0.17	0.51		0.37	12.99	0.39	0.78	0.11	0.63	0.42	0.35	0.09	0.45	0.46	0.40	0.03	00.0	0.67	0.40	1.43	0.11	0.21	0.34	0.24	0.20	0.19	1.14		0.66	0.31	0.48	0.00	0.24	0.32	0.41	
Interaction statistic	Fehrmann ^f	0.14	0.12	1.20	0.06	0.03	0.13	38	0.14	0.39	0.00	28.24	0.01	0.09	0.03	0.07	0.09	0.28	0.08	19.98	0.11	0.01	0.26	0.83		0.38	0.55	0.02	96.0	0.00	0.20	90.0	0.72	0.17	0.79	0.31	0.95	0.24	0.01	89.0	0.27	0.27		0.52	0.27	0.25	0.00	0.10	0.01	0.01	
Interacti	BSGS _e	5.78	5.69	5.49	5.81	0.03	6.49	6.90	6.04	2 48	5.44	16.16	6.41	3.70	6.58	5.70	6.00	6.10	5.19	13.91	5.65	5.85	5.72	5.47	6.22	6.57	5.86	0 0	о. 7.72	0.10	0.07	0.4	14.7	5.76	6.50	5.43	6.04	5.86	6.50	5.88	6.11	5.91	6.77	6.36	6.52	5.70	4.0	20 c	6.42	90.9	
	Associationd	FEZ2 FEZ2	FGD2	FGD2	FLJ20489	T20460	FLJ20489	FI.120489	FLJ20718	FI.143093			FUCA1		FXYD5								GAPT	GATS	GATS			GNEY	GFN3	GF 1.102	Graio2		GPB.177	GPR177	GPR177	GPR177	GPR177	GPR177	GPR177		GSTM1	GSTM1	GSTM1			00011	7500	LOK1	1117	HBG2	
SNP 2	Pos/Mb ^c	36791226	37001267	36999682	48169526	16769566I	48169526	48169526	50106594	36667610	32705248	80827903	24168019	98328559	35660450	141709563	95331048	47567329	76554604	78146016	132678089	235695228	57786110	99827148	99827148	48572632	128972357	85935282	6000000	2007000	6554558	188880113	68732819	68732819	68732819	68732819	68732819	68732819	68732819	101508261	110266754	110266754	110253241	77919015	85877017	19532546	5271671	5271671 213088494	141533832	5309695	
S	Chr.	2 5	1 9	9	12	4.6	7 6	1 6	91	9	9	17	1	13	19	ъ	က	61	4	17	12	61	r)	7	7	14	4 (71 0	7 5	7 .	7 0	n 0	- c	-	1	1	1	1	1	15	-	1	1	C1 ;	1.5	7.7	 		1 4	11	
	rs ID	rs13406184	rs831486	rs831489	rs3782908	rs897511	rs3782908	rs3782908	rs2287197	rs6906101	rs13214069	rs9892064	rs12744386	rs788178	rs2285515	rs11739594	rs13067700	rs17036504	rs1553985	rs12602462	rs10902506	rs7605821	rs10070522	rs2950520	rs2950520	rs2197465	rs1015111	rs/5/7/293	rs/960552	182707210	rs2/0/210	154740540	rs12065581	rs4965745	rs11101992	rs11101992	rs3754446	rs4853333	rs6497007	rs9983949	152000000 1000000000	rs2855059	rs12503379	rs16912979							
	Associationd					FLJ20489					FLJ43093					FXYD5	FXYD5	FXYD5			GAA	GAPT				GDPD3	GDPD3				GPB169	GPB162	70131							GSDMB								HBG2	HBG2		1
SNP 1	Pos/Mb ^c	44321776	46205050	133943951	117036766	48169526	97033129	50626195	43818790	107276627	36667610	80890638	1346063	35695200	55609148	35660450	35660450	35660450	29390239	78153130	78100731	57786110	128038717	66460742	35056572	30102802	30156963	110899955	25084476	0410000	60050015	6005009	124369421	120468039	127939793	11169683	82986268	70506011	171399321	38028634	53192833	85344527	96159560	38399979	38399979	38399979	4023107	5271671	5271671	4523167	
S	Chr.	19	19	10	12	1 5	- 10	19	21	1 -	9	17	71	19	20	19	19	19	7	17	17	ю	10	14	20	16	16	21.	100	0 7	7 5	7 -	2 5	9	1	16	13	18	n	17	10	13	13	22	22	1 17	7 0	1 1 2	: ::	17	
	rs ID	rs2356400	rs4803848	rs902634	rs17615703	rs3782908	rs4984440	rs7204135	rs9325634	rs17112712	rs6906101	rs898095	rs4971478	rs1633921	rs17398183	rs2285515	rs2285515	rs2285515	rs10230232	rs11150847	rs8068856	rs10070522	rs7082031	rs1147447	rs2425256	rs3809624	rs7204270	rs4145072	rs/198646	rstoodogo	rs22/2500	rs2707210	rs11057383	rs12527241	rs12532999	rs725613	rs9575097	rs6566669	rs9290426	rs11557467	rs12248673	rs1547574	rs6492807	rs139898	rs139898	rs139898	rs11075025	rs2855039	rs2855039	rs11078523	
	Chr.	2 0	1 9	9	12	7 5	2 1 2	2 6	191	9 9	9	17	1	19	19	19	19	19	4	17	17	n	υ	7	۲-	16	16	71 5	2 5	7 0	2 5	2 5	7 -	-	1	1	1	-	1	17	-	-	-	52	7.7	7.7	1.	1 =	111	11	
Expression trait	Probe ID ^b	ILMN_1739586	ILMN_2115005	ILMN_2115005	ILMN_1778144	ILMIN-1778144	II.MN 1778144	II.MN 1778144	ILMN_1763663	II.MN 2123450	ILMN_2123450	ILMN_1652333	ILMN_1752728	ILMN_2309848	ILMN_2309848	ILMN_2309848	ILMN_2309848	ILMN_2309848	ILMN_2381758	ILMN_2410783	ILMN_2410783	ILMN_1675191	ILMN_1675191	ILMN_1699631	ILMN_1699631	ILMN_1774901	ILMN_1774901	ILMIN_I790692	ILMIN_3239426	ILMIN-1/30816	ILMIN-1730816	ILMIN 1730816	ILMN 1660549	ILMN_1660549	ILMN_1660549	ILMN_1660549	ILMN_1660549	ILMN_2283325	ILMN_2283325	ILMN_2347193	ILMN_2391861	ILMN_2391861	ILMN_2201580	ILMN_1757467	ILMN_1757467	ILMIN_1757467	ILMIN-1796676	ILMN 1796678	ILMN_1796678	ILMN_2084825	
Ex	Gene IDa	FEZ2 FEZ2	FGD2	FGD2	FLJ20489	FLJ20489	FT.120489	FL.120489	FL.120718	FL.143093	FLJ43093	FN3KRP	FUCA1	FXYD5	FXYD5	FXYD5	FXYD5	FXYD5	G3BP2	GAA	GAA	GAPT	GAPT	GATS	GATS	GDPD3	GDPD3	GNLY	GPN3	GF 1.102	GPR162	GPB169	GPR177	GSDMB	GSTM1	GSTM1	GSTM2	H1F0	HIFO	HIF0	1500	HBG1	HBG1	HBG2							

	Expression trait			-4	SNP 1			•1	SNP 2	•	Interact	Interaction statistic /	- log10 p-values	values	•
Gene ID ^a	Probe ID ^D	Chr.	rs ID	Chr.	Pos/Mb^{c}	Associationd	rs ID	Chr.	Pos/Mb^{c}	Association	$BSGS_e$	$Fehrmann^{I}$	$EGCUT^{t}$	Metag	Distance / Mb ⁿ
HBG2	ILMN_2084825	11	rs12975066	19	35723501	нвсэ	rs2855039	11	5271671	HBG2	5.77	0.08	0.13	0.05	
HBG2	ILMN_2084825	11	rs2855039	: :	5271671	HBG2	rs12503379	4 4	141533832	7.17	86.0	00:00	0.46	0.10	
HDAC7	ILMN_3266186	12	rs2109029	16	6036851		rs4760636	12	48173352	HDAC7	5.75				
HEBP1	ILMN_1802557	12	rs3782567	12	13145613	HEBP1	rs17686635	οο į	135220622		5.98	0.15	0.59	0.32	
HEXDC HI A DBA	ILMN-1741180	17	rs1942719	20 5	71237270		rs7213057	17	80378939	HEXDC HI A DEBE	5.81	1.61	0.34	1.22	
HLA-F	ILMN_1762861	9	rs11660982	f 00	75467313		rs2523404	9	29695713	HLA-H	5.69	1.00	0.47	0.86	
HMBOX1	ILMN_1720059	oo	rs12435486	14	98670849		rs7837237	00	28876221	HMBOX1	6.54	0.92	1.11	1.34	
HMBOX1	ILMN_1720059	œ	rs2837803	21	42112794		rs4732890	œ	28751381	HMBOX1	6.62	0.05	1.01	0.46	
HMBOX1	ILMN_1720059	œ	rs4765451	12	127237464		rs8180944	œ	28904086	HMBOX1	5.80	0.39	3.13	2.52	
HMBOX1	ILMN_1720059	œ	rs587639	œ	132725731		rs7837237	œ	28876221	HMBOX1	6.58	0.55	0.34	0.44	103.850
HMBOX1	ILMN_1720059	œ	rs8180944	00	28904086	HMBOX1	rs4553956	က	189533772		6.88	3.38	0.03	2.20	
HMBOX1	ILMN_1720059	x	rs8180944	00 0	28904086	HMBOX1	rs7810884	- 0	158276926	13000	6.12	0.34	0.66	0.52	
HMBOAL	ILMIN_1720059	XO 1	rs9521666	υ,	170030466		rs8180944	ю 1	28904086	HMBOAI	0.40	0.0	0.20	0.45	0 0 0
HODO153	ILMIN-2101920	0 -	150094200	0 -	119052400		184700010	0 -	110881184	10001117	10.02 0.03 10.00	0.00	9.01	10.01	0.041
HSPC157	ILMN 3194087	-	rs6063164	30	46486900		rs4654783		22439520	HSPC157	5.0				
HSPC157	II.MN 3194087		rs662739	0 -	121229893		rs4654783	-	22439520	HSPC157	6.61				
HSPC157	ILMN 3194087	-	rs7088558	0	101884937	CWF19L1	rs4654783		22439520	HSPC157	6.48				
IL32	ILMN_1778010	16	rs1554999	16	3115628	IL32	rs4759890	12	131757163		6.90	0.19	0.50	0.29	
IL32	ILMN_2368530	16	rs765044	19	2560423	!	rs1554999	16	3115628	IL32	5.53	69.0	0.23	0.44	
INPP5E	ILMN_1811301	6	rs8044524	16	81603771		rs1127152	6	139335599	INPP5E	5.58	1.46	0.84	1.55	
JAZF1	ILMN_1682727	7	rs757355	12	47970693		rs849341	4	28288174		8.16	0.03	0.26	0.05	
KCNJ15	ILMN_1675756	21	rs2186344	21	39606769	KCNJ15	rs424299	11	5570771		5.64	0.65	0.13	0.33	
KIR2DS5	ILMN_1691803	19	rs649216	19	55324635	KIR2DL1	rs6419960	4	189055298		4.74	0.46	0.89	0.77	
KTELC1	ILMN_1811104	က	rs4349034	13	84597119		rs727905	က	119119433	KTELC1	5.53	80.0	08.0	0.37	
KTELC1	ILMN_1811104	က	rs6815953	4	183109012		rs6414283	က	119195913	KTELC1	5.45	0.64	80.0	0.28	
L3MBTL2	ILMN_2336109	55	rs4822006	22	41519362	L3MBTL2	rs1294338	-	233438952		5.88	0.33	0.04	0.09	
LAP3	ILMN_1683792	4	rs7042087	6	132602868		rs7658240	4	17588950	LAP3	5.72	0.24	0.47	0.31	
LAXI	ILMN_1769782	н,	rs1891432	٠,	203877662		rs10900520	н,	203780591		19.16	18.60	11.22	29.24	0.097
LDLKAPI	ILMN_1809040	- t	rs1552032	10	59971635		11710707	⊣ 1	25889632	LDLKAFI	6.00	1	9		
LGALSS	ILMIN-2412214	7.7	rs12450521	10	20083392	111 0 4 5	rs11/49/2/	υ ō	71561407		0.TO	0.35	0.40	0.34	
LINSI	ILMN 2338197	2 12	rs3639332	9 12	101120963	LINSI	rs/1278387	0 0	127804531		0.00	0.43	0.03	0.03	
LRRC25	ILMN 2150196	61	rs6009951	22	51151350		rs8101804	61	18496107	LBRC25	2.68	0.11	0.35	0.15	
LY86	ILMN_1807825	9	rs977785	9	6588881	LY86	rs1543675	н	78946879		5.61	0.13	0.15	0.07	
LYZ	ILMN_1815205	12	rs2168029	12	69734641	LYZ	rs11981725	-1	154137150		5.95	0.15	0.03	0.03	
$_{\rm LYZ}$	ILMN_2162972	12	rs177820	18	77276964		rs2168029	12	69734641	LYZ	5.71	0.49	0.03	0.16	
LYZ	ILMN_2162972	12	rs2168029	12	69734641	LYZ	rs2253135	6	130319560		6.31	0.61	0.36	0.49	
MADILI	ILMN_2358069	,	rs//83/15	, ,	1923385	MADILI	rs6414306	n	127011798	200	5.62	0.25	0.88	0.59	
MADZLIBP	ILMN_1694711	9 6	rs7983718	13	103203146		rs1096699	9 0	43528441	MADZLIBP	5.93	0.63	1.11	1.09	
MAPILCSA	ILMIN_I776188	20	rs974607	77	700010		rsb0b0034	0.7	33351864	MAPILC3A	10.0	1.18	0	п 2	
MBNLI	ILMIN-2313138	00	rs10869600	. c	0202201		rs13069559	9 0	152187451	MBNLI	6.70	67.0 00.0	0.27	0.04	
MBNL1	ILMN_2313158	0 00	rs1164596	13	97100681		rs13069559		152187431	MBNL1	7.38	1.43	0.63	1.34	
MBNL1	ILMN_2313158	8	rs11981513	7	94648239		rs13069559	က	152187431	MBNL1	7.71	0.43	5.36	4.58	
MBNL1	ILMN_2313158	3	rs16864367	8	152234166		rs13079208	8	152116652		13.49	16.25	24.74	41.56	0.118
MBNL1	ILMN_2313158	3	rs2030926	9	114067127		rs13069559	က	152187431	MBNL1	7.10	0.91	5.80	5.53	
MBNL1	ILMN_2313158	8	rs218671	17	6604708		rs13069559	က	152187431	MBNL1	7.63	0.62	5.82	5.23	
MBNL1	ILMN_2313158	no	rs2213360	525	34291750		rs13069559	ကင	152187431	MBNL1	6.05	0.52	0.72	0.70	
MBNLI	ILMN_2313158 ILMN_2313158	0 00	rs2305802 rs2614467	19	16038535 99770138		rs13069559 rs13069559	ာ က	152187431	MBNL1	6.94 5.74	1.67	2.22	5.30	
		,					0	Þ)	1	Continue	Continued on next page

	Expression trait				SNP 1				SNP 2		Interact	Interaction statistic /	$-\log_{10} p$ -values	values	•
Gene ID ^a	Probe ID ^b	Chr.	rs ID	Chr.	Pos/Mb^{c}	Association ^d	rs ID	Chr.	Pos/Mb^{c}	Associationd	$BSGS^{e}$	$Fehrmann^{f}$	$EGCUT^{f}$	Metag	Distance / Mb ^h
MBNL1	ILMN_2313158	e .	rs4392535	4	41513423		rs13069559	8	152187431	MBNL1	8.39	0.02	4.33	3.02	
MBNLI	ILMN_2313158	n 0	rs4735830	x 2	895841		rs13069559	ကဂ	152187431	MBNLI	6.74	0.32	4.21	0.00	
MBNL1	ILMN 2212158	0 0	rs4959550	000	402/0091 57953139		rs1522374	0 0	152233330		7 . 7 2	1 34	 	1 73	
MDNI	II MIN 2212153	00	150120391	4 0 m	0010102		1210004307	0 0	150167491	MDMI 1	1	4 c	1.10	2 0	
MBD	ILMN 2331544	0 00	rs/110/30	000	15462611		rs13009339	o 5	74715653	MBP	6.92	0.00	60.7	9:20	
MBP	ILMN_2398939	18	rs139568	2 2 2	42210985		rs2051344	1 8	74715653	MBP	5.55	0.03	0.23	0.02	
MBP	ILMN_2398939	18	rs2051344	18	74715653	MBP	rs1125539	n	155204939		5.79	0.03	0.76	0.27	
MBP	ILMN_2398939	18	rs2051344	18	74715653	MBP	rs2619046	r.	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	7.06	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	1	12050634	MFN2	5.76	0.61	0.25	0.41	
MGC13057	ILMN_1787526	61	rs12718598	-1	50428445	MGC13057	rs11725347	4	171860973		5.81	0.13	0.30	0.14	
MGC13057	ILMN_1787526	7	rs674608	18	69070772		rs12718598	4	50428445	MGC13057	5.57	0.07	1.03	0.50	
MGC13057	ILMN_1787526	61	rs8058318	16	82628245		rs12718598	7	50428445	MGC13057	7.05	0.11	0.12	0.02	
MGC72104	ILMN_1688318	20	rs845787	20	26197931	MGC72104	rs2660665	œ	137526799		4.17	0.02	0.08	0.03	
MGST3	ILMN_1751956	-	rs740441	17	55779644		rs4147592	1	165600146	MGST3	5.45	0.57	0.27	0.40	
MPZL2	ILMN_1752932	11	rs1805	11	118076069	MPZL2	rs11771552	7	154708716		5.90	0.01	0.23	0.04	
MPZL2	ILMN_1752932	11	rs7316716	12	19953193		rs1805	11	118076069	MPZL2	5.64	0.97	1.08	1.35	
MRPL36	ILMN_1800197	IJ	rs17469061	10	8436432		rs750495	Ю	1782046	MRPL36	68.9	0.34	0.18	0.19	
MRPL43	ILMN_2258774	10	rs6564769	16	80641040		rs2863095	10	102746503	MRPL43	5.71	0.26			
MRPL52	ILMN_1713966	14	rs1950857	14	26710271		rs3811188	14		MRPL52	6.56	0.14	0.44	0.22	
MRPS10	ILMN_1663664	9	rs10955512	œ	110202230		rs722269	9	42194916	MRPS10	7.48	0.46	0.70	0.64	
MRPS10	ILMN_1663664	9	rs11698155	20	15063214		rs2395803	9	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	MTMR10	rs12431444	14	42068689		5.18	1.87	1.87	2.86	
MX1	ILMN_1662358	21	rs459498	21	42795027		rs11160227	14	95514596		6.31	0.46	0.52	0.50	
MX1	ILMN_1662358	21	rs459498	21	42795027		rs4973801	3	26706382		5.83	0.11	0.50	0.23	
MX1	ILMN_1662358	21	rs459498	21	42795027		rs8130120	21	29363604		6.78	0.29	0.92	0.65	13.431
MYBPC3	ILMN_1781184	11	rs10134030	14	61593110		rs1317149	11	47486885	MYBPC3	5.56	0.13	0.46	0.23	
MYBPC3	ILMN_1781184	11	rs7322768	13	109550561		rs7124681	11	47529947	MYBPC3	5.70	0.04	0.08	0.02	
MYOM1	ILMN_1680344	18	rs4798075	18	3247256	MYOM1	rs2737422	œ	134485237		6.02	0.74	0.15	0.40	
N4BP1	ILMN_2201966	16	rs12444224	16	87580855		rs11649236	16	48632478	N4BP1	5.54	2.00	0.59	1.77	38.948
NAAA	ILMN_1668605	4 -	rs2707575		147638723		rs6826085	4.	76870229	NAAA	5.65	0.20	0.03	0.04	
NAAA	ILMIN_2391512	40	rszU/1856	71 0	144669661	THE CONTRACTOR	rs0820085	4 -	108/0229	NAAA	0.40	0.27	0.43	0.30	
NAPPT1	II MN 1410465	0 0	152123133	0 0	144663661	NAPPTI	152/50019	H 0	144619690		0.00	10.01	0.40	20.10	080 0
NAPRT1	II.MN 1710752	0 00	rs2123758	oo	144663661	NAPRTI	rs4862705	0.4	187445552		7. E. E.	1.27	010		0000
NAPRT1	ILMN_1710752	00	rs2123758	00	144663661	NAPRT1	rs6455553	9	167811764		6.12	0.87	0.76	1.01	
NAPRT1	ILMN_1710752	œ	rs2123758	œ	144663661	NAPRT1	rs700276	-1	146189057		98.9	1.10	2.58	2.77	
NAPRT1	ILMN_1710752	œ	rs2123758	œ	144663661	NAPRT1	rs7571561	5	213386267		6.03	0.13	0.47	0.23	
NAPRT1	ILMN_1710752	œ	rs2208123	22	48214812		rs2123758	00	144663661	NAPRT1	6.60	0.29	0.88	0.63	
NAPRT1	ILMN_1710752	œ	rs4743420	6	103488089		rs2123758	œ	144663661	NAPRT1	5.50	0.12	0.17	0.08	
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	61	234721287		5.58	2.11	0.44	1.71	
NCL	ILMN_2121437	61	rs7563453	61	232301670		rs4973397	7	232291471		7.31	7.51	6.33	12.70	0.010
NDUFA12	ILMN_1737738	12	rs2746971	22	37101890		rs11107847	12	95386791	NDUFA12	3.88	0.39	0.18	0.22	
NMT2	ILMN_1656378	10	rs10906857	10	15239498	NMT2	rs12490878	n (183114008		6.84	0.42	0.34	0.35	
NOD2	ILMN_1762594	91	rs2967636	61.5	7067773		rs9302752	91	50719103	NOD2	5.90	0.24	0.04	90.0	
NRBF2	ILMN 3237385	2 2	rs2375269	7 :	69876894		rs7923609	0 1	65133822	NRBF2	5.53				
														Continu	Continued on next page

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 PAM PAM PAM PAM <t< td=""><td>ILMN_1734542</td><td>- 1</td><td>rs347331</td><td>n :</td><td>140148107</td><td></td><td>rs1264894</td><td>-</td><td>111969719</td><td>CVGFI</td><td>6.04</td><td>0.25</td><td>1.21</td><td>0.82</td><td></td></t<>	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 rest208233 12 49151303 PGLYRP1 rest208237 14 7784444 6.54 0.54 0.05 22 rest208233 19 40151306 PGLYRP1 rest208238 19 6.64 0.57 0.03 0.05 22 rest40444 22 31075185 PIK3BP1 rest2082341 1 7788697 PC 0.51 0.03 0.05 22 rest618772 22 32203131 PIK3BP1 PKD 7.1 0.03 0.05 22 rest618772 22 32203131 PIK3BP1 PKD 1 7.1 0.03 0.00 22 rest618772 22 32203131 PKD 1 7.1 0.03 0.00 22 rest61877 22 3220314 PKD 1 0.03 0.00 0.00 <t< 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></t<>	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 PHKZH 1778808 PHCA 6.51 0.69 0.60 22 1847072 22 3167518 PHKZH 18208887 PKZH 0.50 0.00 0.00 22 1867672 22 3199917 PHKZH 18208687 0.00 0.00 0.00 22 1867672 22 3199917 PHKZH 18208687 0.00 0.00 0.00 22 1867672 22 3199917 PHKZH 18208787 0.00 <td>ILMN_1660232</td> <td>12</td> <td>rs7495797</td> <td>15</td> <td>27246462</td> <td></td> <td>rs4329748</td> <td>12</td> <td>7364442</td> <td>PEX5</td> <td>5.74</td> <td>0.34</td> <td>0.00</td> <td>0.13</td> <td></td>	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 22 3157156 PRINT rs4004831 1 76708086 PHCA 5.51 0.03 0.09 22 rs440440 22 3157156 PISD rs506531 1 1788697 PGD 0.09 0.09 22 rs440440 22 33234931 PISD rs50404851 1 1.0182681 PCD 0.00 0.09 2 rs476587 22 33234931 PISD rs504046 2 1.0182481 0.00 0.00 1 rs1050470 1 1.0182681 PPR 1.018269 PPR 0.00 0.00 1 rs1050470 1 1.0182681 PPR 1.018475 PPR 0.00 0.01 0.00 1 rs1050470 1 1.018471 PPR 1.018471 PPR 0.01 0.01	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 61728/69 1 61728/69 1 1 61728/69 1 1 61728/69 1 2 1 1 1 1	II.MN 1812552	-	rs493642	=	123097386		rs10736812	-	76708086	PHCA	10	0.36	0 0	0.70	46 389
2.2 ind/10072 2. 2026333 PISD ind/100833 14 30368867 5.2 0.62 0.87 0.87 2.2 ind/10072 2. 32364031 PISD ind/10072 2. 3036918 PISD ind/10072 2. 3036040 0.0 1.0 0.0 <	11.MN 1719986	66	ro4141404	000	31675185	PIK3ID1	200000000000000000000000000000000000000	-	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 185781644 ref.28046 9 14087108 PNEAT 5.15 0.05 0.04 1 ref.12314603 15 18578064 ref.28046 9 14087108 PPERBY 5.15 0.05 0.04 1 ref.12314603 15 1858064 ref.1210009 1 212447167 PPERBY 5.15 0.03 0.04 1 ref.12402256 12 18580644 ref.1210009 1 212447167 PPERBY 5.15 0.03 0.04 1 ref.12402256 12 185030044 ref.1210009 1 21244767 PPERBY 5.65 0.03 0.03 1 ref.124026 1 12144767 PPERBY 5.75 0.08 0.13 1 <td< td=""><td>ILMIN_I 793934</td><td>7.7</td><td>rsp518752</td><td>7.7</td><td>31999127</td><td>FISD</td><td>rs954627</td><td>-</td><td>18236681</td><td></td><td>7.11</td><td>0.00</td><td>1.19</td><td>0.48</td><td></td></td<>	ILMIN_I 793934	7.7	rsp518752	7.7	31999127	FISD	rs954627	-	18236681		7.11	0.00	1.19	0.48	
2 res6869411 5 ISSENGIO PRABLA PNKD 6:35 0.16 0.704 1 res1163998 6 4527100 res226046 9 14487108 0.31 0.73 0.78 14 res1163998 6 4527100 res226046 res1150807 1 7559930 PPPERBA 6.33 0.72 0.43 14 res1291019 20 4666255 res1150600 1 212447167 PPPERBA 5.63 0.72 0.43 1 res1291001 2 16222691 res12120009 1 212447167 PPPERBA 5.63 0.72 0.43 1 res8622694 1 17747238 res1120009 1 212447167 PPPERBA 5.61 0.03 0.13 1 res8622607 1 107417238 res1120009 1 212447167 PPPERBA 5.62 0.03 0.14 1 res903261 1 107417238 res1100099 1 2124	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 5.15 0.33 0.33 14 res12910109 20 5836086 res1120000 1 212447167 PPPRR5A 5.63 0.72 0.48 1 res1283256 12 13560804 res12120009 1 212447167 PPPRR5A 5.67 0.08 0.36 1 res188325 14 9504042 res12120009 1 212447167 PPPRR5A 5.65 0.30 0.38 1 res6028334 14 9504042 res12120009 1 212447167 PPPRR5A 5.65 0.39 0.37 1 res6028343 14 9504042 res12120009 1 212447167 PPPRR5A 5.65 0.39 0.31 1 res6018283 16 1508048 <t< td=""><td>ILMN_1774604</td><td>7</td><td>rs6869411</td><td>S</td><td>158781604</td><td></td><td>rs4672884</td><td>7</td><td>219182481</td><td>PNKD</td><td>6.35</td><td>0.16</td><td>0.04</td><td>0.04</td><td></td></t<>	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 PPP2RAG 5.81 0.12 0.44 1 rs12914603 15 5835064 rs11156875 14 36198146 PPP2RAG 5.63 0.72 0.48 1 rs12422255 12 125596064 rs12120009 1 21447167 PPP2RAG 5.63 0.05 0.95 1 rs682334 11 107417238 rs12120009 1 21447167 PPP2RAG 5.63 0.05 0.36 1 rs682334 11 107417238 rs12120009 1 212447167 PPP2RAG 5.63 0.05 0.36 1 rs76757871 6 135030045 rs12120009 1 212447167 PPP2RAG 5.63 0.05 0.30 1 rs7675787 15 2500009 1 212447167 PPP2RAG 5.63 0.05 0.30 1 rs28019823 14 5600886 1 121447	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 271444775 rs1000990 1 212447167 PPP2R5A 5.65 0.13 0.14 1 rs7871177 rs1000990 1 212447167 PPP2R5A 5.72 0.16 0.13 1 rs20188555 16 2386774 rs11049773 16 12633869 7.34 4.77	ILMN_1662617	14	rs12914603	15	58350896		rs11156875	14	35619816	PPP2R3C	5.81	0.12	0.42	0.19	
1 rest8492835 12 12555664 res12120009 1 212447167 PPP2R5A 5.72 0.08 0.05 1 res682334 11 10741228 res12120009 1 212447167 PPP2R5A 5.61 0.08 0.03 1 res682334 11 10741238 res12120009 1 212447167 PPP2R5A 5.62 0.08 0.03 1 res682334 11 10741238 res12120009 1 212447167 PPP2R5A 5.62 0.08 0.37 1 res682834 16 28867776 res1200099 11 212447167 PPP2R5A 5.73 0.05 0.11 2 res1209231 23 2867776 res1200099 11 21244767 PPP2R5A 5.73 0.05 0.11 2 res1209231 23 24867776 res1200099 11 21244767 PPPRS 5.73 0.01 0.14 2 res1209231 21 4793468	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 4777782 6 7.34 0.05 0.11 2 rs2802951 1 12777470 rs1107058 1 17087744 PSMB1 5.74 0.04 0.21 4 rs6028864 1 170823379	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	Т	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 45068862 C21ORF57 res1207114 PARBH 5.79 0.03 0.044 6 res4890648 18 43983954 res13207114 FSMBH 5.79 0.00 0.04 6 res608030 20 30047822 pre608089 1 2777444 PSMBH 5.74 0.00 0.26 6 res608080 20 30047823 res12207144 PSMBH 5.74 0.04 0.26 1 res7299449 12 137287957 res1220714 1702877957 4.58 0.08 0.08	ILMN_1738784	1	rs7871178	6	27148475		rs12120009	1	212447167	PPP2R5A	5.72	0.16	0.30	0.16	
16 res188355 16 2386776 120104775 16 12639800 7.34 0.53 0.11 21 rs1288355 16 2386776 421 rs10493793 16 12639800 7.34 0.53 0.11 21 rs288372 21 48063862 221078740 rs107013 1 4776382 C210RF57 4.81 0.69 4.47 6 rs3802607 11 121774705 rs6128843 6 17080384 8 17080384 9.00 0.26 0.26 6 rs6060830 20 3034782 rs6128843 6 17080384 8 17080384 9.00 0.02 0.02 0.02 6 rs6060830 20 3034782 rs10320714 6 17087744 PSMB1 5.14 0.04 0.05 12 rs6060830 20 3034782 rs10320714 6 17087744 PSMB1 5.44 0.04 0.05 12 rs608020	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 res280923 21 47931653 C21ORF57 18 41777344 PSMB1 5.76 0.19 0.04 6 res380507 11 121774705 res928843 6 170877444 PSMB1 5.74 0.00 0.26 6 res4800648 18 43983854 res928433 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 17089034 PSMB1 5.14 0.00 0.21 12 res6028846 17089034 1 12277976 6 17089034 1.03 0.03 0.44 12 res615622 1 1 170877444 PSMB1 1.084874 0.00 0.02 0.44<	ILMN_1713603	16	rs2188355	16	23867776		rs10492793	16	12639800		7.34	0.53	0.11	0.25	11.228
21 res2839372 21 48068862 res11701058 21 4775382 C210RF57 4.81 0.69 4.47 6 res386057 11 121774705 res1220714 6 17087744 PSMB1 5.79 0.04 6 res3860568 13 43883854 res9295415 6 17082379 PSMB1 5.14 0.00 0.26 6 res6080830 20 3034782 res6080843 6 17082379 7.44 0.04 0.02 6 res6080830 20 3034782 res618089 1 27082379 7.45 0.04 0.02 12 res6080830 20 3034782 res1080384 PSMB1 res208044 6 1.08 4.47 12 res608080 1 20 3034782 res1080321 1 2721825 PTMB1 5.4 0.04 0.05 12 res631562 1 1 7221825 PTMDS21 5.0 0.03 <t< td=""><td>ILMN_1675038</td><td>21</td><td>rs1029231</td><td>21</td><td>47931653</td><td>C21ORF57</td><td>rs958127</td><td>18</td><td>31497346</td><td></td><td>5.60</td><td>0.19</td><td>0.03</td><td>0.04</td><td></td></t<>	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 762854548 RABACI res7656537 1	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 re43856 1 76598123 re11036212 11 5221825 PTDSS1 5.00 0.08 0.08 1 re4381602 1 76598238 RABACI re1036212 11 5221825 PTDSS1 5.70 0.03 0.48 1 re341778 1 re340278 1 17023	ILMN_1789176	9	rs3862607	11	121774705		rs13207114	9	170877444	PSMB1	5.79		0.44		
6 res0060830 20 3034783 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 res2720836 1 2574744 PSMB1 5.45 1.18 0.32 12 res2383 67 1 568123 res10320714 6 17087744 PSMB1 5.50 0.03 0.048 12 res2383 67 1 7658123 1 521825 PTDSS1 5.00 0.03 0.08 12 res631562 1 7658123 res1036212 1 5221825 PTDSS1 5.70 0.02 0.03 12 res631562 1 7628424 1 7628682 QPPR 5.75 0.03 0.03 13 res041730 2 3337574 RFMD RFMD 1 70233726 QPPR 6	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 22579957 4.58 1.95 0.64 12 rs7239674 12 131727816 rs12207114 6 17087744 PSMB1 5.42 1.95 0.64 12 rs235367 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 rs4669206 17 76584246 rs100820773 4 17526682 QDPR 5.70 0.03 0.48 12 rs2417728 6 106348246 rs10020773 4 17526682 QDPR 5.70 0.03 0.40 12 rs2417738 19 44407788 RARACI rs7836367 12 7023576 6.42 0.25 0.03 0.48 11 rs4937702 16 55526551	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 126854248 res11036212 11 5221825 PTDSS1 5.70 0.02 0.03 12 res494676 6 1063428246 res10020773 4 17526682 QDPR 5.75 1.03 0.05 19 res1075728 19 4467788 RABACI res7051628 11 7016117 6.55 0.25 0.05 16 res9087702 16 5526551 AKTIP res166344 15 20638488 RCNI 6.32 0.03 0.31 11 res1087913 12 RCNI res1087448 RCNI 4.32 0.04 0.09 1 res1087579 11 res1087645 102740645 0.	ILMN_1789176	9	rs7299749	12	131727816		rs13207114	9	170877444	PSMB1	5.42	1.18	0.32	98.0	
12 res4669205 17 76598123 res11036212 11 5221825 PTDSS1 5.90 0.08 0.08 12 res431562 11 126852438 res1036212 11 5221825 PTDSS1 5.70 0.02 0.04 14 res4946705 6 105348246 res10020773 4 17526882 QDPR 5.77 0.02 0.40 12 res247704 8 12 7023576 QDPR 6.42 0.25 0.08 16 re3931702 16 53526551 AKTIP res1863464 15 26938488 RCNI 6.32 0.03 0.31 11 res1087702 11 32136436 RCNI res136436 RCNI 4.32 0.03 0.31 11 res4922579 11 32136436 RCNI res1341899 1 102740645 6.40 0.04 0.04 0.06	ILMN_1743049	12	rs2353567	14	95478823		rs11036212	11	5221825	PTDSS1	5.00	0.03	0.48	0.15	
12 re631562 11 122656438 re11036212 11 5221825 FTDSS1 5.70 0.02 0.02 0.04 12 re3401730 22 33375704 re7305307 12 70235726 6.55 0.25 0.08 0.08 19 re1075728 19 42462788 RABACI re7305307 12 70235726 6.55 0.25 0.08 19 re1075728 19 42462788 RAFILP re1863344 15 20433488 6.38 0.03 0.31 11 re10877913 12 4114715 RFMIL re18633448 15 2043488 RCNI 6.38 0.03 0.31 11 re4922579 11 32136436 RCNI re11047468 RCNI 4.32 0.41 0.09 11 re4922579 11 102740645 6.43 0.04 0.04 0.26	ILMN_1743049	12	rs4969205	17	76598123		rs11036212	11	5221825	PTDSS1	5.90	08.0	80.0	0.38	
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	
19 rs1075728 19 42467788 RABACI rs7951628 11 120161117 6.42 0.28 0.84 16 rs9931702 16 53526551 AKTIP rs1863364 15 26938488 6.42 0.28 0.31 11 rs1927313 12 41147155 rs1427557 11 32136436 RCN1 rs11177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCN1 rs1341899 1 102740645 5.40 0.04 0.26	ILMN_1803197	12	rs241730	22	33375704		rs7305307	12	70235726		6.55	0.25	0.08	0.09	
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 RCNI rs4922579 11 32136436 RCNI 65.23 0.58 0.37 11 rs4922579 11 32136436 RCNI rs1146957 8 14177468 4.32 0.41 0.09 11 rs4922579 11 32136436 RCNI 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	

Part	Expression trait				SNP 1				SNP 2		Interac	Interaction statistic	$-\log_{10} p$ -values	/alues	
ILAN 1803280	Probe ID ^b	Chr.	rs ID	Chr.	Pos/Mb^{c}	Associationd	rs ID	Chr.	Pos/Mb^{c}	Associationd	$BSGS_{e}$	Fehrmann ^f	$\mathtt{EGCUT}^{\mathrm{f}}$	Metag	Distance / Mb ^h
ILAN 2027706	ILMN_1802380		rs4982958	14	24987865		rs301819	1	8501786	RERE	5.66	0.61	1.23	1.17	
ILANI 1786-329 1 medical size medical size 1 medical size medical si	ILMN_2327795		rs11085829	19	13174312		rs301819		8501786	RERE	5.12	0.21	0.10	0.00	
ILANI 1780533 14 midoli24896 14 21102800 ILANI 1780536 13 midoli245 14 midoli24896 14 midoli2489 15 midoli2489 17 midoli2489 18 midoli2489	ILMN_2327795	-	rs3852011	က	112844086		rs301819	1	8501786	RERE	5.71	0.08	09.0	0.26	
ILANN 1785457 1 miltoria 1 miltoria miltori	ILMN_1780533	14	rs11628398	14	21182800	RNASE6	rs7324365	13	100601327		5.48	0.42	0.21	0.26	
LANK 17975 1	ILMN-1780533	14	rs6603134	19	8106521 4875566		rs11628398	13	54668512	KN ASE6	5.11	0.09	0.22	0.08	
ILINK 1778347 1 mit 1772 1 mit 172 1 mit	ILMN_1794726	17	rs400688	17	4839930	RNF167	rs11706900	9 00	36348968		5.59	0.71	0.46	0.64	
ILANY 2183287 1	ILMN_1738347	1	rs1107121	21	46127549		rs2819365	1	201983242		6.27	0.11	0.30	0.13	
LINK 176721 16 R8051234 16 80502035 16	ILMN_1738347	1	rs8071611	17	67153386		rs2819365	1	201983242		4.32	1.48	0.52	1.28	
ILMN 21207570 1	_	16	rs352935	16	89648580		rs2965817	16	89513234		4.98	3.79	14.41	17.24	0.135
ILMN 1289938		61	rs1401202	16	80320056		rs4849261	61	114450028	RPL23AP7	5.55	0.13	0.73	0.38	
ILMN 1209369 14 \$10002022 14 \$10002021 RPL86AL RF150299 0 60137200 0 60132 0	_	14	rs3007033	14	50103816	RPL36AL	rs17495030	6	138038093		5.46	0.09	90.0	0.02	
ILMN 1704771 St. 192084454 St. 194019446 ILMN 1704778 ILMN 1704771 St. 19404471 St	_	14	rs4900928	14	50020817	RPL36AL	rs1502991	9	66137260		5.86	0.32	0.20	0.19	
ILMN.1764721 8 malaboral mathematical mathe	ILMN_1764721	œ	rs2958482	œ	145984615	RPL8	rs1619856	П	234585790		4.59	0.10	0.37	0.15	
ILMN.17095478 11 mil.17085428 1 mil.048.0221 1 mil.04.220788 1 mil.04.22078 1 mil.	ILMN_1764721	00	rs4143674	20	4741304		rs2958482	œ	145984615	RPL8	4.33	0.13	0.45	0.22	
ILMN.1002677 ILMN.100267 ILMN.1	ILMN_3297880	3	rs4889214	16	80913946		rs696221	6	10342876	SEC13	6.48				
ILMN.1090.027 11 rig.1474-00 14 104412137 rig.848.66 11 94900111 SESN3 5.50 0.02 0.01 ILMN.1090.027 11 rig.955.89 15 94900111 SESN3 5.50 0.02 0.01 ILMN.1090.027 11 rig.955.89 14 49490511 14 49490511 5.50 0.02 0.01 0.01 0.02 0.01	ILMN_1702787	-1	rs17085428	ю	95388015		rs7695	1	156147326	SEMA4A	5.70	0.22	1.73	1.17	
ILMN.10694027 11 res684596 15 46691793 SESSA9 1 res685456 11 46691793 SESSA9 1 res684564 1 46691793 SESSA93 1 res684564 1 46691793 SESSA9343 1 43898365 1 43898363 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43898373 1 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 4 43893734 43893734 43893734 43893734 438937344 43893734 438937344 43893734 <	ILMN_1694027	111	rs12147460	14	104412137		rs684856	11	94906111	SESN3	5.50	0.03	0.51	0.15	
ILMN.10624627 11 reseased 11 14906111 RESASS 14006427 18 18406426 10 0.02 0.02 0.01 ILMN.1062764 6 res2545385 6 66883965 181364034 3 56840749 PPBP 5.52 0.07 0.01 ILMN.1072764 6 res2545385 5 66883960 18196926 18196926 0.00 0.02 0.02 0.01 ILMN.1072764 6 res2645386 5 18196926 0.00 18196926 0.00 0.01 0.02 0.01 ILMN.2082806 11 res107326 12 2223826 SLC22A18 res1107703 0.00 0.01 0.00 0.01 ILMN.2082806 11 res967036 11 res967036 18 res967036 18 res110704 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 0.00	ILMN_1694027	111	rs355391	15	46591793		rs684856	11	94906111	SESNS	5.67	0.31	90.0	0.10	
ILMN.1762764 6 reg2463881 11 18989686 rej346384 3 66449749 PPBP 5.97 0.70 0.51 ILMN.1762764 6 reg445304 4 6849749 9 PPBP 5.97 0.70 0.51 ILMN.1762764 6 reg445304 4 6849749 9 PPBP 5.97 0.02 0.51 ILMN.1762764 6 rej353683 1 1 12836883 3 0.02 0.18 ILMN.2382065 11 rej367035 11 2928360 12 2928360 1 2028360 1 2028360 0.03 0.03 ILMN.2382065 11 rej04380 11 2928360 1 2928360 1 2028360 0.03 0.03 ILMN.2382065 13 rej04380 1 2928360 2 1 1 0.03 0.03 ILMN.2382065 13 rej04380 1 rej043806 1 rej043406 1	ILMN_1694027	111	rs684856	11	94906111	SESN3	rs7004947	œ	134606425		5.60	0.21	0.51	0.31	
Image: 1.5 Image: 1.5 Image: 2.5 Ima	SH3BGRL2 ILMN_1762764	9	rs10838191	11	43893658		rs1354034	c	56849749	PPBP	5.52	0.70	0.12	0.35	
ILMN 238256 6 rest645394 4 8826652 Rest2734 5 5 5 3 0	Н	9	rs2545385	ro	66383979		rs1354034	n	56849749	PPBP	5.97	0.20	0.51	0.30	
ILMN 1771801 20 se1034120 21 18108622 2 se1034120 21 se108622 2 se1034120 20 se1034005 se103400	-	9	rs6845304	4	88280502		rs1354034	07	56849749	PPBP	5.23	0.32	0.71	0.53	
IMANIATION 20 rel55883 20 161891 SIRPG res62759 4 6048651 5.74 0.29 0.13 ILMN 238506 11 res67736 11 2928856 11 2928856 SLC22A18 res677104 2 20.28 C.0.2 0.19 0.13 ILMN 238506 11 res677036 11 292886 SLC22A18 res771064 2 5.22 0.19 0.19 0.13 ILMN 238506 11 res698508 12 252846 SLC22A18 res771064 2 5.26 0.10 0.13 ILMN 147878 18 res698508 17 5.262893 SLC22A18 res771096 5 5.26 0.10 0.13 ILMN 147880 1 res608508 17 5.26 0.10 0.13 0.10 0.10 ILMN 147880 1 res60857 1 1.7459803 1 1.7459803 1 1.750449 1.00 0.10 0.00 0.10 0.0		6	rs1034120	21	18196922		rs17455517	6	131785369	SH3GLB2	7.40	0.22	0.18	0.13	
LMN 2382505 11 res167326 12 2923826 SLC22A18 res110874 7 212324779 5.47 0.09 0.10 ILMN 2382506 11 res67735 11 2923826 SLC22A18 res110874 7 24167828 6.15 0.39 0.10 ILMN 2382506 11 res667035 11 24046744 SLC2A18 res11087818 6.15 0.39 0.10 ILMN 2382506 13 res69806 17 44357744 SLC46A3 SLC46A3 5.28 0.10 0.09 ILMN 145778 18 res64806 17 44357744 SLC46A4 5.28 0.09 0.09 0.08 ILMN 145778 18 res64806 17 4461500 SMOX res10494 SLC46A3 SLC46A3 <td< td=""><td></td><td>20</td><td>rs1535883</td><td>20</td><td>1612819</td><td>SIRPG</td><td>rs6842739</td><td>4</td><td>60489510</td><td></td><td>5.74</td><td>0.29</td><td>0.18</td><td>0.17</td><td></td></td<>		20	rs1535883	20	1612819	SIRPG	rs6842739	4	60489510		5.74	0.29	0.18	0.17	
ILMN 238505 11 res6f7035 11 2993886 SLC22A18 re371064 7 15324179 5.70 0.15 0.15 0.13 ILMN 238505 11 res6f734 SLC22A18 re3772034 2 L4468 7 155801067 5.85 0.13 0.13 ILMN 1255611 3 res698508 8 12433774 SLC45A4 re771703 3 125801067 5.85 0.10 0.13 0.13 ILMN 1705853 1 res603325 1 res603325 1 15480006 8 1.00 0.58 ILMN 1705853 1 res603462 1 55602008 8 1.00 0.09 0.09 ILMN 170384 1 res603462 1 17390199 1 1.00 0.09 0.09 ILMN 170384 1 res603462 1 17390199 1 1.00 0.09 0.09 ILMN 170384 1 res646834 1 1701655 NORD14 1.00 0.	SLC22A18 ILMN_2382505	11	rs11673260	19	52181798		rs367035	11	2923826	SLC22A18	5.47	0.00	0.24	0.09	
ILMN 1285205 11 res272225 SLC22A18 res7777064 2 241678528 G.15 0.39 0.13 ILMN 2385106 3 res101216 1 24816743 SLC2A18 res777703 5 14168073 5.28 1.08 0.08 ILMN 174477 3 res10323 13 res08508 8 142337734 SLC45A4 ref771016 5 17468073 5.08 0.08 0.08 ILMN 174477 3 res00523 13 res00482 N. res00523 1 res00482 SLC46A3 5.52 0.07 0.05 ILMN 1775380 11 res00482 N. res00482 N. S.66 0.39 0.17 ILMN 179381 11 res204463 1 res00482 N. 0.39 0.05 ILMN 179381 11 res204466 2 res104786 N. res104786 N. R. R. 0.00 N. R. 0.00 R. 0.00 0.0		11	rs367035	11	2923826	SLC22A18	rs3110874	7	153224179		5.70	0.15	0.10	0.06	
ILMN.12556111 3 resp92136 11 24616743 EAST EAST <td></td> <td>111</td> <td>rs367035</td> <td>11</td> <td>2923826</td> <td>SLC22A18</td> <td>rs3772054</td> <td>61</td> <td>241678528</td> <td></td> <td>6.15</td> <td>0.39</td> <td>0.13</td> <td>0.19</td> <td></td>		111	rs367035	11	2923826	SLC22A18	rs3772054	61	241678528		6.15	0.39	0.13	0.19	
ILMN.1705653 13 194987734 S.C45A4 Fr9701916 5 17458073 5.95 0.86 0.07 ILMN.1705653 13 156908506 15 97403923 SLC45A4 Fr97011916 5 17458073 SLC46A3 5.55 0.06 0.07 ILMN.1705653 13 158036259 15 97403923 SMOX 4161500 SMOX 17403923 SMC7 6.52 0.09 0.05 ILMN.170653 11 15204249 15 47403923 SMOX 1741 1759149 SNORD14A 6.50 0.07 0.05 ILMN.1709381 11 15204249 15 46259108 Fred466334 11 1759149 SNORD14A 7.31 1.03 ILMN.1709381 11 152924241 1759149 SNORD18A 6.50 0.07 0.05 ILMN.2328662 2 1759243 177562 NUPN 1775783 2 101889306 SNORD18A 6.51 0.03 0.05 ILMN.232		3	rs1912136	11	24616743		rs6771703	က	125801067	SLC41A3	5.88	1.10	0.82	1.24	
ILMN.1766539 13 re9032054 17 556020991 SLC46A3 5.5.2 0.09 0.58 ILMN.1766539 1 re9032059 17 55602091 SMCT 6.52 0.19 0.09 ILMN.176380 20 re8118315 20 4161500 SMOX re11677815 2 6500092 SMHCR 6.52 0.19 0.09 0.58 ILMN.176380 20 re8118315 20 4161500 SMOX re11677815 2 6500092 SMHCR 6.60 0.39 0.09 0.58 ILMN.176380 1 re116045863 2 1.229409 SMCRD144 6.00 0.29 1.03 ILMN.176393 1 re2034490 1 re705783 SMCRD144 6.00 0.29 1.03 ILMN.228662 2 re1160582 1 1.2296324 1 1701567 SMORD89 6.33 0.03 1.03 ILMN.228662 2 re8114097 re767783 2 101889906<		œ	rs6985508	œ	142337734	SLC45A4	rs7701916	ю	174598073		5.95	0.86	0.07	0.40	
ILMN 1776359 1 9740923 SMOT 6.52 0.17 0.00 ILMN 1776359 1 rs1015315 2 6500802 SMGT 6.56 0.39 0.62 ILMN 1776389 2 rs1016621 9 133060233 SMOX rs1057315 4 119225940 SNHGS 6.11 0.09 ILMN 1799381 11 rs105621 15 46259108 rs705783 2 101889306 SNORD14A 6.00 0.29 1.03 ILMN 1799381 11 rs1044863 2 115929241 rs4040863 2 101889306 SNORD18A 6.00 0.29 1.03 ILMN 2238662 2 rs1044863 2 1122986326 SNORD18A 6.13 0.02 1.03 ILMN 2328662 2 rs1044863 2 101889306 SNORD8B 6.03 0.02 ILMN 2328662 2 rs113664 2 4637628 SNUPN rs4756783 101889306 SNORD8B 6.38 0.03	ILMN_1658639	13	rs949805	17	55602091		rs7981190	13	29259349	SLC46A3	5.52	0.09	0.58	0.26	
ILMN 1775380 20 restlistifs 20 4161500 SMOX restlistifs 2 4161500 SMOX restlistifs 2 4161500 SMOX restlistifs 2 65600837 4 11929499 SNHCB 6.11 0.39 0.62 ILMN 1799381 11 restlistifs 2 115292224 1 1733127 4 1929499 SNORD144 6.00 0.29 1.03 ILMN 1799381 11 restlistifs 2 11529224 1 1733132 1.03 0.02 ILMN 1738862 2 restlistifs 2 11529224 1 1753949 5.96 3.9 0.03 ILMN 173862 2 restlistifs 2 101889306 SNORD89 6.35 0.13 1.41 ILMN 1739179 15 restlistifs 2 101889306 SNORD89 6.35 0.13 1.41 ILMN 1779179 15 restlistifs 3 101889306 SNORD89 6.38 0.03		-1	rs8035259	15	97403923		rs10911353	1	183489203	SMG7	6.52	0.17	0.09	0.06	
ILMN.1399349 4 rs1105621 9 133050233 rs705837 4 119225940 SNHG8 6.11 0.03 1.03 ILMN.1799381 11 rs1264622 11 17339127 rs6486334 11 17291499 SNORD14A 6.66 0.29 1.03 ILMN.1799381 11 rs2664462 11 17339127 rs6486334 11 17291499 SNORD14A 6.60 0.29 1.03 ILMN.328862 2 rs1046863 2 11 15296326 SNORD189 5.96 6.33 1.03 ILMN.328662 2 rs1046863 21 46376528 SNUPN rs718536 1 7.03 6.45 0.03 ILMN.328662 15 rs8134646 21 46376528 SNUPN rs4774078 2 101889906 SNORD89 6.33 0.03 ILMN.2210729 15 rs8134646 21 46376528 SNUPN rs4774078 1 75616105 STYXL1 5.54 0.07	ILMN_1775380	20	rs8118315	20	4161500	SMOX	rs11677815	61	65800982		5.68	0.39	0.62	0.52	
ILMN_1799381 11 res154042 15 46259108 res14607 11 17291499 NNRD14A 6.60 0.29 1.03 ILMN_1799381 11 res1524462 15 46259108 res4466334 11 1715557 7.31 13.11 10.96 ILMN_1238662 2 res10445863 2 115929241 res750783 2 101889306 SNORD89 6.60 0.29 1.03 ILMN_2328862 2 res160682 11 122988306 SNORD89 6.58 6.08 0.00 ILMN_2328862 1 res160683 11 res160683 10 4637652 SNUPN res160683 10 6.45 0.01 ILMN_234685 15 res17668 SNUPN res176585 SNUPN res176586 SNUPN res176586 Res176596	_	4	rs1105621	6	133050233		rs705837	4	119225940	SNHG8	6.11				
A ILMN.3238662 1 1733912	Ī.	111	rs1520429	15	46259108		rs214097	11	17291499	SNORD14A	09.9	0.29	1.03	0.72	
ILMN.3238662 rs10448863 2 rs10444863 2 rs10448863 2 rs10448864 2 rs10448863 2 rs10505822 rs10605822 rs10605822 rs10605822 rs10605822 rs10605822 rs10605822 rs10605822 rs10605822 rs10505832 rs10505832 rs10405865 rs104189306 rs1041806 rs104189306 rs1041806 rs10	A	111	rs2634462	11	17339127		rs6486334	11	17015557		7.31	13.11	10.96	23.22	0.324
ILMN 23238662	_	2	rs10445863	7	115929241		rs750783	7	101889306	SNORD89	80.9				14.040
ILMN 1236862		010	rs11605822	11	122986326		rs750783	01 (101889306	SNORD89	5.96				
ILMN.1723922 15 rs8134946 21 49376528 SNUPN rs1472075 19 19 19 19 19 19 19 1		N	rs2135064	. C	26778066		rs750783	21 5	101889306	SNORD89	6.33			0	
ILMN_L7239159 15 F8812490 2 41017869 1 F88121400 2 41017869 1 F88121400 2 41017869 1 F88121400 2 41017869	ILMIN_1735932	011	TSS134040	7 6	403/05/28	SNOFN	TS/180502	10	000000000000000000000000000000000000000		0.4.0 0.1	0.13	1.41	0.00	
ILMN.177602 13 res221406 14 res221406 15 res221406 15 res221406 16 res221406 17 res221406 18 res221406 19 res221406 10 res222140 10 res222240 10 res2222240	-	. H	rsol34040	17	40370328	SINOFIN	rs1472013		45659086	CDATARI	0.0 2.0 2.4	#c.0	0.00	0.00	
ILMN_2240722	_		re2221406	13	90174596		154114330		72509713	TOUTUE	. v	0.67	0.10	0 88	
ILMN.2345142	_	1.	rs4073164	21	104947517		rs17685	1 1	75616105	STYXL	, rd	0.57	0.17		
16 rs1463965 18 74332954 rs3785354 16 28550667 TUFM 7.05 0.01 0.05 16 rs2886657 21 40119768 rs378534 16 28550667 TUFM 5.83 0.01 0.05 9 rs6099026 20 56013994 rs485485 13 10410782 rs485485 11 85495269 SYTL2 5.47 0.28 0.31 1 rs1375719 13 10410782 rs4072037 1 155162067 THBS3 5.55 0.03 0.31 1 rs804955 11 155162067 THBS3 5.55 0.03 0.15 1 rs804956 12 15419480 THBS3 5.55 0.03 0.15 1 rs804956 2 1614583 1 15149480 THPR3 5.55 0.07 0.40	ILMN_2345142	20	rs11700063	20	46153148	SULF2	rs939294	. 4	180439236		5.51	0.46	0.24	0:30	
16 rs2886657 21 40119768 rs3785554 16 28550667 TUFM 5.83 0.26 0.16 1 rs609966 20 56013994 rs485485 1 8.43 6.14 0.26 0.16 1 rs18099875 13 103410782 rs485485 1 1.55162067 7THBS3 5.55 0.03 0.31 1 rs81039875 14 206887978 1 155162067 THBS3 5.55 0.03 0.15 1 rs80149876 14 206887978 1 151404809 TIPRL 5.22 0.07 0.40	ILMN_2336133	16	rs1463965	18	74332954		rs3785354	16	28550667	TUFM	7.05	0.01	0.05	0.00	
9 rs6099626 20 56013994 rs3118663 9 136281753 SURF6 6.14 0.26 0.16 11 rs1375719 13 103410782 rs48585 11 8549269 SYTL2 5.47 0.28 0.31 1 rs1987779 11 9422867 14 20687978 15.55 0.03 0.15 1 rs2823245 21 16745523 165154980 THPRS 5.55 0.07 0.40	ILMN_2336133	16	rs2836657	21	40119768		rs3785354	16	28550667	TUFM	5.83				
11 rs1375719 13 103410782 rs485485 11 84495269 SYTL2 5.47 0.28 0.31 1 rs1939875 11 95422867 1 155162067 THBS3 5.55 0.03 0.15 1 rs20404966 14 20687978 rs1320993 1 15615489 THPR.3 5.65 0.31 0.76 1 rs2223245 21 16745523 1 168154599 TIPRL 5.22 0.07 0.40	ILMN_1778032	6	rs6099626	20	56013994		rs3118663	6	136281753	SURF6	6.14	0.26	0.16	0.14	
1 res1898875 11 99422886 res0472037 1 155162067 THBS3 5.55 0.03 0.15 1 res2823245 21 16746523 res1280983 1 168154599 TIPRL 5.22 0.07 0.40	ILMN_2336609	111	rs1375719	13	103410782		rs485485	11	85495269	SYTL2	5.47	0.28	0.31	0.24	
1 rs204956 14 20687978 rs2049805 1 155194980 THBS3 5.65 0.31 0.76 1 rs2823245 21 16745523 rs1320993 1 168154599 TIPRL 5.22 0.07 0.40	ILMN_1804663	П	rs1939875	11	95422867		rs4072037	1	155162067	THBS3	5.55	0.03	0.15	0.03	
1 182823245 21 16/45523 181320993 1 168154599 11FKL 5.22 0.07 0.40	ILMN_1804663		rs8014956	14	20687978		rs2049805		155194980	THBS3	5.65	0.31	0.76	0.55	
	ILMN-1781457	1	rs2823245	21	16745523		rs1320993	1	168154599	TIPRE	5.22	0.07	0.40	0.15	

	Distance / Mbh				0.122																				0.031		12.131					5.389																45.345			Continued on next page
ralues	ಹ	0.70	0.70		145.78	3.67	3.78	2.52	0.03	2.87	00.9	8.00	2.27	0.19	3.51	7.36	10.72	2.10	9.20	4.47		0.32	0.07	0.62	4.09	0.29	0.36	1.07	0.68	0.08	0.59	0.16	0.44	0.20	27.0	01.0		1.01	0.56	0.02	0.13	0.40	0.69	0.11	1.69	0.39	0.06				Continued
$-\log_{10} p$ -values	EGCUT	1.34	0.40		45.78	3.09	1.18	1.00	0.07	0.77	3.33	9.61	1.52	0.33	3.62	5.15	8.80	3.14	96.9	5.75		0.12	0.15	0.17	1.89	0.40	0.01	1.60	0.87	0.18	0.47	0.24	0.38	0.00	0.30	0.00		0.78	0.55	0.02	0.26	98.0	06.0	0.25	1.23	0.91	0.18				
Interaction statistic /	Fehrmann ^f	0.06	0.10	0.76	81.55	1.55	3.61	2.41	0.08	3.06	3.72	0.04	1.57	0.19	06.0	3.31	3.06	0.07	3.36	0.10		0.64	0.11	1.03	3.19	0.28	0.93	0.21	0.37	0.12	0.63	0.21	0.50	0.04	0.20	0.10	1	0.85	0.51	0.14	0.14	0.08	0.36	0.11	1.20	0.04	0.02				
Interacti	BSGS _e F	5.70	6.79	11.09	12.16	8.12	0.00	7.37	6,95	6.93	6.21	7.30	6.70	5.92	8.89	8.55	5.80	5.49	6.22	9.44	5.60	5.79	5.61	5.52	8.23	5.61	5.52	5.97	6.92	7.79	6.43	6.38	6.51	80.7	0.00	0.17	21.57	7.73	8.10	6.71	7.34	7.05	7.41	5.42	5.92	6.46	6.00	5.01	5.51 6.34	6.13	
	Associationd	TMED4	TMEM149	TMEM149	TMEM149																TMEM63A	TMEM80	IRF5	IRF5		TRAPPC4	TRAPPC4										TRAPPCS	TRAPPC5	TRAPPC5			RAPGEF1		TREM1	TREM1	TRIM38	TSPAN14	TSPAN32			
SNP 2	Pos/Mb ^c	44581986	36219525	36219525	36147315	4799159	188359436	128884559	64268976	90932598	13822381	113317583	147619772	171792273	129595460	233879066	161683974	80357420	242889492	21473952	226027323	656845	128593948	128593948	23498358	118887887	118887887	166970604	132022957	156404902	242329791	2369415	57495457	129644342	146600096	85439550	7758194	7758194	7758194	228504503	30408765	134635088	157393770	41264577	41264577	26044369	82273079	2317951	137947208 238746880	85147633	
	Chr.	۲.	6.	19	19	01	0.00	12	18	14	œ	4	7	IJ	11	61	9	17	1	13	1	11	7	7	7	11	11	n	œ	9	!	61	2.7	7,	1 1	- 7	6.	19	19	2	16	6	က	9	9	9	10	11	0 01	16	
	rs ID	rs17725246	rs8106959	rs8106959	rs7254601	rs10508289	rs10937361	rs1401098	rs1557335	rs17719594	rs1843357	rs2351458	rs2539000	rs2731711	rs471728	rs6718480	rs6926382	rs7213338	rs914940	rs9509428	rs4149226	rs4963126	rs10488630	rs10488630	rs11770192	rs3916581	rs3916581	rs10059004	rs1023095	rs1375714	rs1393299	rs17763599	rs4968328	rs/313302	TS1094991	181800930	rs17159840	rs17159840	rs17159840	rs10179572	rs12921440	rs1887778	rs963354	rs2395771	rs2395771	rs2032447	rs10748526	rs12800998	rs620607 rs1198819	rs4783126	
	Associationd				SNX26	TMEM149								TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPOS	TRAPPOS	TOAPTO	TRAPPOR												MYBPC3	ECGF1	ECGF1															
SNP 1	Pos/Mb ^c	132389627	27925288	45207005	36268923	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	36219525	72890603	58058246	4859303	22287303	23528927	113531675	131018917	7758194	7758194	7758194	7758194	7758194	7758194	7758194	7756104	7758107	22740855	45128454	11272861	7762978	7762978	7762978	7762978	85749398	108256422	158808416	27194634	47663049	2317951 50971266	50966914	
	Chr.	11	22	20	19	61	161	13	19	19	19	19	19	19	19	19	19	19	19	19	13	19	6	20	7	13	11	19	19	19	19	13	61	1.0	n -	10	22	21	20	19	19	19	19	12	10	-1	17	Ξ:	22	22	
	rs ID	rs1940400	rs5762235	rs6090518	rs807491	rs8106959	rs1254086	rs1548475	rs1537146	rs199793	rs7776572	rs1278760	rs1793823	rs17159840	rs17159840	rs17159840	rs17159840	rs17159840	rs17159840	rs1/159840	rs17159640	re17159840	rs380708	rs3916995	rs6040514	rs7246264	rs7246264	rs7246264	rs7246264	rs10862975	rs12412964	rs2527180	rs968726	rs10838738	rs12800998 rs140522	rs470119															
	Chr.	7.	61	19	19	61.0	61	61	13	19	19	19	19	19	19	19	19	19	19	19	-	11	-	-	-	11	11	19	19	13	13	61	5 6	5 6	9 0	10	61	19	19	19	19	19	19	9	9	9	10	Ξ:	22	22	
Expression trait	Probe ID ^b	ILMN_1804148	ILMN 1786426	ILMN_1786426	ILMN_1786426	ILMN-1786426	ILMN_1786426	ILMN 1786426	ILMN_1786426	ILMN_1719649	ILMN_1708482	ILMN_1683811	ILMN_1683811	ILMN_1731043	ILMN_1814650	ILMN_1814650	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMIN-2372639	ILMIN-23/2639	II MN 2272630	ILMIN 2372639	ILMN 2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_2372639	ILMN_1688231	ILMN_1688231	ILMN_1697971	ILMN_1785060	ILMN_1718621	ILMN_2389970 ILMN_3223126	ILMN_3223126												
Exi	Gene IDa	TMED4	TMEM149	TMEM63A	TMEM80	TNP03	TNP03	TRA2A	TRAPPC4	TRAPPC4	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPOS	TRAPPOS	TOAPPOS	TRAPPOR	TRAPPCS	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TRAPPC5	TREM1	TREM1	TRIM38	TSPAN14	TSPAN32	TYMP	TYMP																		

_	_	_							_		_	_	_	_	_	_							_			_
	Distance / Mb ^h			1.643	0.088																					
values	Metag	0.52	1.10	0.03	4.95	0.46	0.57		0.19	0.41	0.31	0.17	0.04	1.21	0.16	0.57	0.26	1.47	0.09	1.22	0.35	2.25	1.63	0.15	0.46	0.05
$-\log_{10} p$	$\mathtt{EGCUT}^{\mathrm{f}}$	0.42	1.29	0.14	5.14	0.15	0.69		0.19	0.74	0.48	0.17	0.19	1.15	0.02	0.54	0.17	1.38	0.13	1.35	0.61	1.43	0.17	0.36	0.27	0.01
Interaction statistic / $-\log_{10} p$ -values	$Fehrmann^{f}$	0.59	0.48	0.03	0.94	0.84	0.39		0.33	0.16	0.23	0.31	0.03	0.73	0.46	0.53	0.48	0.81	0.19	0.57	0.18	1.64	2.38	0.09	0.67	0.26
Interacti	BSGS _e I	5.91	6.01	5.71	5.09	5.64	5.44	5.72	5.77	6.44	5.74	6.44	5.82	6.12	4.83	5.60	5.71	5.88	5.88	6.34	5.85	4.86	5.48	5.79	5.29	6.04
	Associationd					VNN2	VNN2	VNN2	VNN2	VNN3	VNN3	VNN3	VNN3	VNN3	VNN3			VSTM1	WDR48	WDR48	WDR48	WDR6		ZFP90	ZNF500	ZYX
SNP 2	Pos/Mb^{c}	83600397	214514361	75151717	45974668	133077063	133072650	133072650	133072650	133067782	133067782	133067782	133067782	133067782	133067782	71024750	123098249	54553697	39091812	39067925	39044116	49194331	93119799	68573945	4799041	143093824
	Chr.	16	П	17	19	9	9	9	9	9	9	9	9	9	9	18	10	19	က	8	က	8	15	16	16	4
	rs ID	rs7201194	rs7512594	rs7225546	rs2276470	rs1883613	rs1883617	rs1883617	rs1883617	rs2267952	rs2267952	rs2267952	rs2267952	rs2267952	rs2267952	rs4552100	rs7895870	rs10500316	rs6778963	rs883349	rs7619193	rs11715581	rs12591171	rs1182968	rs2290560	rs2242601
	Associationd	UBASH3A	UBASH3A	USP36												VSTM1	VSTM1			RAPGEF1			XAF1			
SNP 1	Pos/Mb^{c}	43855067	43855067	76794981	46063167	105252718	9116155	49927332	16834510	151662184	73006453	75547169	83262064	16594253	51692548	54553697	54553697	30261219	188927822	134635088	102624790	123371708	6673170	37040648	48283177	8935312
01	Chr.	21	21	17	19	-1	20	22	11	-1	œ	6	14	21	13	19	19	22	4	6	13	11	17	21	22	20
	rs ID	rs1893592	rs1893592	rs2279308	rs1264226	rs10435352	rs13044386	rs134447	rs216495	rs10278073	rs1443946	rs348462	rs7157055	rs2823165	rs9596457	rs10500316	rs10500316	rs9625870	rs1388935	rs1887778	rs9554833	rs12362253	rs1533031	rs909446	rs4823723	rs6056281
	Chr.	21	21	17	19	9	9	9	9	9	9	9	9	9	9	19	19	19	က	8	က	8	17	16	16	7
Expression trait	Probe ID ^b	ILMN_2338348	ILMN_2338348	ILMN_1697227	ILMN_1743646	ILMN_1678939	ILMN_1678939	ILMN_1678939	ILMN_1678939	ILMN_1804935	ILMN_1804935	ILMN_1804935	ILMN_1804935	ILMN_2387680	ILMN_2387680	ILMN_1763455	ILMN_1763455	ILMN_1763455	ILMN_1762103	ILMN_1762103	ILMN_1762103	ILMN_1669484	ILMN_2370573	ILMN_1684628	ILMN_1700238	ILMN_1701875
EX	Gene IDa	UBASH3A	UBASH3A	USP36	VASP	VNN2	VNN2	VNN2	VNN2	VNN3	VNN3	VNN3	VNN3	VNN3	VNN3	VSTM1	VSTM1	VSTM1	WDR48	WDR48	WDR48	WDR6	XAF1	ZFP90	ZNF500	ZYX

Table S1 - continued from previous page

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

Table S3: Concordance of sign of epistatic variance components between discovery and replication datasets

Test	Interactions ^a	Dataset	n^{b}	Expected ^c	Observed ^d	<i>p</i> -value
$1^{\rm e}$	All	EGCUT	434	217.00	306	6.69×10^{-18}
		Fehrmann	434	217.00	278	5.04×10^{-9}
		Both	434	108.50	221	5.56×10^{-31}
	Significant	EGCUT	30	15.00	25	3.25×10^{-4}
		Fehrmann	30	15.00	24	1.43×10^{-3}
		Both	30	7.50	22	3.76×10^{-8}
2^{f}	All	EGCUT	434	54.25	92	4.22×10^{-7}
		Fehrmann	434	54.25	79	6.18×10^{-4}
		Both	434	6.78	30	2.55×10^{-11}
	Significant	EGCUT	30	3.75	19	9.46×10^{-11}
		Fehrmann	30	3.75	19	9.46×10^{-11}
		Both	30	0.47	18	2.23×10^{-25}
$\overline{3^{g}}$	All	EGCUT	1133	566.50	775	7.10×10^{-36}
		Fehrmann	1133	566.50	726	1.90×10^{-21}
		Both	1133	283.25	562	1.39×10^{-70}
	Significant	EGCUT	73	36.50	55	1.69×10^{-5}
		Fehrmann	73	36.50	55	1.69×10^{-5}
		Both	73	18.25	46	7.86×10^{-12}

 $^{^{\}rm a}$ "All" denotes 434 discovery interactions and "Significant" denotes 30 interactions with significant replication $p\text{-}{\rm values}$

^b Number of tests for concordance

 $^{^{\}rm c}$ Expected number of concordant cases under the null hypothesis of no interactions

^d Observed number of concordant cases

 $^{^{}m e}$ The sign of the most significant epistatic variance component in discovery is the same as the corresponding variance component in the replication data.

^f The largest epistatic variance component in the discovery is the same as in the replication with the same sign in both.

^g The sign of all epistatic variance components in the discovery with p < 0.05 are the same as the corresponding variance components in the replication data.

Table S4: Concordance of sign of epistatic variance components between discovery and replication datasets using test 4

Interactions ^a	Dataset	$n^{ m b}$	$0_{\rm c}$	1^{c}	2^{c}	3^{c}	4^{c}	p
Expected ^d	-	-	0.06	0.25	0.38	0.25	0.06	-
All	EGCUT	434	0.06	0.22	0.41	0.23	0.08	0.194
All	Fehrmann	434	0.07	0.22	0.39	0.24	0.08	0.385
All	Combined	868	0.07	0.22	0.40	0.23	0.08	0.0448
Significant	EGCUT	30	0.07	0.03	0.30	0.33	0.27	4.72×10^{-4}
Significant	Fehrmann	30	0.03	0.07	0.33	0.27	0.30	6.69×10^{-4}
Significant	Combined	60	0.05	0.05	0.32	0.30	0.28	5.49×10^{-8}

 $^{^{\}rm a}$ "All" denotes 434 discovery interactions and "Significant" denotes 30 interactions with significant replication $p\text{-}{\rm values}.$

^b Number of tests for concordance.

 $^{^{\}rm c}$ Proportion of tests that have 0, 1, 2, 3 or 4 concordant signs between discovery and replication.

^d Expected proportion of concordant signs under the null hypothesis of no epistasis.

Table S5: Details on linkage disequilibrium and relative positions of all discovery cis-cis interactions

TMEMI49	Chr	Gene	SNP 1	SNP 2	Position 1	Position 2	Distance / Mb	R^2	D'
CSTB									
MBNL1			rs898095	rs9892064	80890638	80827903		0.063	
10	21		rs9979356	rs3761385	45230974	45198355	0.033	0.041	0.066
Transfer	3	MBNL1	rs16864367	rs13079208	152234166	152116652	0.118	0.041	0.117
17	10		rs2395095	rs10824092	76446305	75929517	0.517	0.013	
NAPRT1	11	CTSC	rs7930237	rs556895	88117962	88077479	0.040	0.012	0.045
LAX1	17	GAA	rs11150847	rs12602462	78153130	78146016	0.007	0.000	0.001
MBP	8	NAPRT1	rs2123758	rs3889129	144663661	144613680	0.050	0.053	0.060
SNORD14A	1	LAX1	rs1891432	rs10900520	203877662	203780591	0.097	0.065	0.106
21 C210RF57 rs9978658 rs11701361 48027084 47764477 0.263 0.032 0.065 16 RPL13 rs352935 rs2965817 89648580 89513234 0.135 0.054 0.060 19 ATP13A1 rs4284750 rs873870 19810050 19738554 0.071 0.008 0.015 2 NCL rs7563453 rs4973397 232301670 232291471 0.010 0.027 0.029 5 HNRPH1 rs6894268 rs4700810 179032488 178991794 0.041 0.000 0.001 19 VASP rs1264226 rs2276470 46063167 45974668 0.088 0.018 0.022 7 TRA2A rs776572 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs1244224 rs11649236 8758055 48	18	MBP	rs8092433	rs4890876	74747424	74732087	0.015	0.035	0.053
16 RPL13 rs352935 rs2965817 89648580 89513234 0.135 0.054 0.060 19 ATP13A1 rs4284750 rs873870 19810050 19738554 0.071 0.008 0.015 2 NCL rs7563453 rs4973397 232201670 232291471 0.010 0.027 0.029 5 HNRPHI rs6894268 rs4700810 179032488 178991794 0.041 0.000 0.001 19 VASP rs1264226 rs2276470 46063167 45974668 0.088 0.018 0.022 7 TRA2A rs7776572 rs1177101058 48663862 47776882 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs773589 157216093 1	11	SNORD14A	rs2634462	rs6486334	17339127	17015557	0.324	0.008	0.012
NCL	21	C21ORF57	rs9978658	rs11701361	48027084	47764477	0.263	0.032	0.065
2 NCL rs7563453 rs4973397 232301670 232291471 0.010 0.027 0.029 5 HNRPH1 rs6894268 rs4700810 179032488 178991794 0.041 0.000 0.001 19 VASP rs1264226 rs2276470 46063167 45974668 0.088 0.018 0.022 7 TRA2A rs7775672 rs11770192 23528927 23498358 0.031 0.064 0.064 21 PRMT2 rs2839372 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12749343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 <td< td=""><td>16</td><td>RPL13</td><td>rs352935</td><td>rs2965817</td><td>89648580</td><td>89513234</td><td>0.135</td><td>0.054</td><td>0.060</td></td<>	16	RPL13	rs352935	rs2965817	89648580	89513234	0.135	0.054	0.060
5 HNRPH1 rs6894268 rs4700810 179032488 178991794 0.041 0.000 0.001 19 VASP rs1264226 rs2276470 46063167 45974668 0.088 0.018 0.022 7 TRA2A rs7776572 rs11770192 23528927 23498358 0.031 0.064 0.064 21 PRMT2 rs2839372 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157166014 0.052 0.005 0.006 1 OVGP1 rs10802822 rs184655 37771578 <t< td=""><td>19</td><td>ATP13A1</td><td>rs4284750</td><td>rs873870</td><td>19810050</td><td>19738554</td><td>0.071</td><td>0.008</td><td>0.015</td></t<>	19	ATP13A1	rs4284750	rs873870	19810050	19738554	0.071	0.008	0.015
19 VASP rs1264226 rs2276470 46063167 45974668 0.088 0.018 0.022 7 TRA2A rs7776572 rs11770192 23528927 23498358 0.031 0.064 0.064 21 PRMT2 rs2839372 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.00 0.00 11 PHCA rs493642 rs10736812 1	2	NCL	rs7563453	rs4973397	232301670	232291471	0.010	0.027	0.029
7 TRA2A rs7776572 rs11770192 23528927 23498358 0.031 0.064 0.064 21 PRMT2 rs2839372 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs28668504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386	5	HNRPH1	rs6894268	rs4700810	179032488	178991794	0.041	0.000	0.001
21 PRMT2 rs2839372 rs11701058 48063862 47776382 0.287 0.100 0.122 12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs2896940 rs13332406 57721127	19		rs1264226	rs2276470	46063167	45974668	0.088	0.018	0.022
12 OAS1 rs13311 rs2072133 113448652 113409260 0.039 0.002 0.016 16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.001 16 AKTIP rs2886940 rs13332406 57721127	7	TRA2A	rs7776572	rs11770192	23528927	23498358	0.031	0.064	0.064
16 N4BP1 rs12444224 rs11649236 87580855 48632478 38.948 0.007 0.021 5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs1655031 46614102	21	PRMT2	rs2839372	rs11701058	48063862	47776382	0.287	0.100	0.122
5 CAST rs12719343 rs7733671 125369113 96000269 29.369 0.001 0.001 7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs1655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120	12	OAS1	rs13311	rs2072133	113448652	113409260	0.039	0.002	0.016
7 DNAJB6 rs2286842 rs3779589 157216093 157163614 0.052 0.005 0.006 1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731	16	N4BP1	rs12444224	rs11649236	87580855	48632478	38.948	0.007	0.021
1 OVGP1 rs10802822 rs1264898 240132968 111992823 128.140 0.008 0.030 20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs1655031 46614102 30833162 15.781 0.000 0.001 2 CYBRD1 rs88427 rs7591849 172368120 160112881 12.255 0.000 0.000 2 CYBRD1 rs88427 rs7591849 172368120 160112881 12.255 0.000 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917	5	CAST	rs12719343	rs7733671	125369113	96000269	29.369	0.001	0.001
20 CD93 rs2868504 rs1884655 37771578 23074375 14.697 0.000 0.002 11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636	7	DNAJB6	rs2286842	rs3779589	157216093	157163614	0.052	0.005	0.006
11 PHCA rs493642 rs10736812 123097386 76708086 46.389 0.002 0.008 21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs88427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 <td>1</td> <td>OVGP1</td> <td>rs10802822</td> <td>rs1264898</td> <td>240132968</td> <td>111992823</td> <td>128.140</td> <td>0.008</td> <td>0.030</td>	1	OVGP1	rs10802822	rs1264898	240132968	111992823	128.140	0.008	0.030
21 MX1 rs459498 rs8130120 42795027 29363604 13.431 0.000 0.000 16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776<	20	CD93	rs2868504	rs1884655	37771578	23074375	14.697	0.000	0.002
16 AKTIP rs2896940 rs13332406 57721127 53489705 4.231 0.000 0.001 17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3411188 26710	11	PHCA	rs493642	rs10736812	123097386	76708086	46.389	0.002	0.008
17 CDK5R1 rs9905940 rs11655031 46614102 30833162 15.781 0.000 0.000 2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C17ORF60 rs9907897 rs7405659 635	21	MX1	rs459498	rs8130120	42795027	29363604	13.431	0.000	0.000
2 CYBRD1 rs888427 rs7591849 172368120 160112881 12.255 0.000 0.000 8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C170RF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 19 TRAPPC5 rs17159840 rs17763599 77	16	AKTIP	rs2896940	rs13332406	57721127	53489705	4.231	0.000	0.001
8 HMBOX1 rs587639 rs7837237 132725731 28876221 103.850 0.001 0.001 11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C170RF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7	17	CDK5R1	rs9905940	rs11655031	46614102	30833162	15.781	0.000	0.000
11 TRAPPC4 rs1793823 rs3916581 131018917 118887887 12.131 0.001 0.002 12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C17ORF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 3323493	2	CYBRD1	rs888427	rs7591849	172368120	160112881	12.255	0.000	0.000
12 PEX5 rs10444467 rs4329748 128052636 7364442 120.688 0.000 0.000 12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C17ORF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.003 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 GPR162 rs27272500 rs2707210 79685913 </td <td>8</td> <td>HMBOX1</td> <td>rs587639</td> <td>rs7837237</td> <td>132725731</td> <td>28876221</td> <td>103.850</td> <td>0.001</td> <td>0.001</td>	8	HMBOX1	rs587639	rs7837237	132725731	28876221	103.850	0.001	0.001
12 FLJ20489 rs17615703 rs3782908 117036766 48169526 68.867 0.001 0.002 16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C170RF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 <td>11</td> <td>TRAPPC4</td> <td>rs1793823</td> <td>rs3916581</td> <td>131018917</td> <td>118887887</td> <td>12.131</td> <td>0.001</td> <td>0.002</td>	11	TRAPPC4	rs1793823	rs3916581	131018917	118887887	12.131	0.001	0.002
16 PRKCB1 rs2188355 rs10492793 23867776 12639800 11.228 0.000 0.000 14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C17ORF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	12	PEX5	rs10444467	rs4329748	128052636	7364442	120.688	0.000	0.000
14 MRPL52 rs1950857 rs3811188 26710271 23299135 3.411 0.002 0.004 17 C17ORF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	12	FLJ20489	rs17615703	rs3782908	117036766	48169526	68.867	0.001	0.002
17 C17ORF60 rs9907897 rs7405659 63502633 59874129 3.629 0.004 0.011 6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	16	PRKCB1	rs2188355	rs10492793	23867776	12639800	11.228	0.000	0.000
6 FLJ43093 rs6906101 rs13214069 36667610 32705248 3.962 0.000 0.000 19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	14	MRPL52	rs1950857	rs3811188	26710271	23299135	3.411	0.002	0.004
19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	17	C17ORF60	rs9907897	rs7405659	63502633	59874129	3.629	0.004	0.011
19 TRAPPC5 rs17159840 rs17763599 7758194 2369415 5.389 0.000 0.000 22 PISD rs715572 rs6518754 33234931 32097775 1.137 0.001 0.003 12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	6	FLJ43093	rs6906101	rs13214069	36667610	32705248	3.962	0.000	0.000
12 DIP2B rs871257 rs12427378 117994348 51074199 66.920 0.001 0.001 12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	19	TRAPPC5	rs17159840		7758194		5.389	0.000	0.000
12 GPR162 rs2272500 rs2707210 79685913 6902002 72.784 0.003 0.005	22	PISD	rs715572	rs6518754	33234931	32097775	1.137	0.001	0.003
	12	DIP2B	rs871257	rs12427378	117994348	51074199	66.920	0.001	0.001
17 USP36 rs2279308 rs7225546 76794981 75151717 1.643 0.000 0.000	12	GPR162	rs2272500	rs2707210	79685913	6902002	72.784	0.003	0.005
	17	USP36	rs2279308	rs7225546	76794981	75151717	1.643	0.000	0.000