BCAT1 is a NOTCH1 target and sustains the oncogenic function of NOTCH1

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SUPPLEMENTARY DATA:

Figure S14. BCAT1 expression correlates with prognosis in NOTCH1-dependent leukemias and represents a therapeutic target in T-ALL

Figure S15. BCAT inhibition synergizes with numerous chemotherapeutic drugs to reduce cell viability

Figure S16. BCAT1 inhibition synergizes with etoposide to reduce viability

MATERIALS AND METHODS

Cell lines and primary leukemia samples. Human embryonic kidney (HEK) 293T cells were maintained in DMEM containing 10% fetal bovine serum (FBS) and 0.05 mg/ml penicillin/streptomycin. All T-ALL cell lines were maintained in RPMI-1640 media supplemented with 10% FBS and 0.05 mg/ml penicillin/streptomycin. We tested cell lines regularly for mycoplasma contamination. Primary T-ALL cells were expanded in vivo via i.v. injection in 6-8 weeks old female NOD SCID IL2Rγnull (NSG) immunodeficient mice. T-ALL cells from spleens of xenografted mice were cultured in vitro in MEM-alpha media supplemented with 10% human serum and cytokines for the duration of functional assays (48-72h). Patient derived xenograft (PDX) and cell line authentication was determined by analyzing several loci of short tandem repeats (STRs) using a commercial kit (PowerPlex 16 HS System, Madison, WI, USA). NOTCH1-induced T-ALL murine models were previously generated by transduction of bone marrow progenitors with activated forms of NOTCH1 oncogene (*NOTCH1 L1601P ΔPEST* or *ΔE-NOTCH1*)[1]. Spleens of diseased mice were used as a source of murine T-ALL cells for further studies. Thymuses from 6 weeks old normal C57/BL6 mice were obtained. Procedures involving animals and their care conformed with institutional guidelines and were authorized by local (OPBA) and national (Italian Ministry of Health) animal ethical committees.

Mouse transplantation experiments. Bcat1 knockout ($^{-/-}$; KO) mice on a C57BL/6J background were generated using the CRISPR/Cas9 technology by Cyagen, (CA, USA). NOTCH1-induced T-ALL tumors were generated in mice as previously described [2]. Briefly, bone marrow (BM) cells were collected from 6- to 12-week-old WT and *Bcat1* KO C57BL/6 mice and BM progenitors (Lin-) were purified by negative selection using magnetic sorting (Miltenyi Biotec, Bergisch Gladbach, Germany). The cells were cultured overnight in the presence of the following cytokines (all from Peprotech, London, U.K.): mIL-3 (10 ng/mL), mIL-6 (10 ng/mL), mFLT3L (50 ng/mL), mIL7 (100 ng/mL) and mSCF (50 ng/mL). The cells were then washed, resuspended in retroviral supernatant (ΔE-NOTCH1), placed in the same cytokine cocktail containing polybrene (4 μg/mL), and centrifuged at 1,290g for 90 minutes. A second round of spinoculation was performed the following day. After flow cytometric analysis of transduced progenitors, approximately 50×10^4 $Lin^-/Sca1^+/GFP^+$ cells of each genotype were injected i.v. into lethally irradiated (9 Gy) recipients (6–8-week-old C57BL/6 female mice). Mice were bled after 2–3 weeks to monitor engraftment and evaluate the presence of circulating immature T cell progenitors by flow cytometry. Tumour bearing mice were euthanized and primary tumour cells were extracted from their spleens. For in vitro studies, Δ*E-NOTCH1* tumors were cultured in RPMI-1640 supplemented with 20% FBS, mIL-7 (10 ng/mL), mIL-2 (5ng/mL) and β-mercaptoethanol. Procedures involving animals and their care conformed with institutional guidelines and were authorized by local (OPBA) and national (Italian Ministry of Health) animal ethical committees.

Flow cytometry and analysis of T-cell distribution. Peripheral Blood (PB) and spleens were harvested from WT and KO mice. Red blood cell (RBC) lysis was performed using a hypotonic solution containing ammonium chloride for all samples. Briefly, the cells were blocked for 10 minutes with CD16/CD32 (mouse BD FC Block, BD Pharmingen, Oxford, U.K.) diluted 1:100 in PBS at 4°C and subsequently stained for 30 minutes with a combination of following panel of antibodies: Cd3e-BV421/BV510 (Biolegend, London., U.K.), Cd8-BV605/PE, Cd4-FITC/APC (all from BD Pharmingen). The fixable viability stain dye (FVS780; BD) was used to analyze only viable cells. Cells were analyzed on a BD LSR II flow cytometer and acquired data was analyzed with FlowJo (Tree Star Inc., Ashland, OR).

Quantitative real-time PCR. Total RNA from human and mouse samples were extracted using Trizol reagent (Invitrogen, Thermo Fisher Scientific, Waltham, MA, USA). RNA from thymic samples were from a previous study[3]. These samples were obtained as surgical tissue discards from pediatric patients, ranging in age from 2 days to 5 years, undergoing cardiac surgery at the University Hospital of Padova, after informed consent. cDNA was generated with the Super Script First Strand Synthesis System for RT-PCR (Invitrogen) and analyzed by quantitative real-time PCR using SYBR Green PCR Master Mix (Applied Biosystems, Paisley, UK) and the HT 7900 Real-Time PCR System (Applied Biosystems). All primers were KiCqStart™ Primers from Sigma-Aldrich. Primer sequences are available upon request. Every sample was analyzed in triplicate and relative expression levels were normalized to RPL19 or β2-microglobulin expression using the ΔΔCT method.

Total histone extraction. Total histones were obtained using the EpiQuik total histone extraction kit (Epigentek, Farmingdale, NY. USA), according to the manufacturer's recommendations. Histone extracts were normalized for protein concentration using the Bradford method (Pierce).

Immunohistochemistry. All primary T-ALL (and T-cell lymphoblastic lymphoma; T-LBL) cases were retrieved from the archives of the Pathology Unit of Padua University Hospital (Padua-Italy). Patient derived xenograft (PDX) samples were previously generated[4, 5]. Immunohistochemical (IHC) analysis was performed on 4 μm-thick formalin-fixed paraffin-embedded (FFPE) tissue sections with the Bond Polymer Refine Detection kit in an automated immunostainer (BOND-MAX system; Leica Biosystems–Newcastle upon Tyne, UK), as previously described[6]. IHC analyses were run using the following primary antibodies: anti-BCAT1 (clone 51/ECA39, BD Pharmingen), anti-HES1 (clone D6P2U, Cell Signaling Technology), anti-BCAT2 (clone D8K3O, Cell Signaling Technology). Immunostains were performed on whole tissue sections. Appropriate positive and negative controls were also included. Thymic tissue (N=3) was run in parallel to assess BCAT1, BCAT2 and HES1 expression in normal T cell precursors. The following two-tiered scoring system was used to assess the expression of these markers: (i) low expressor: no staining (0) or weak positivity (+1) in <10% of tumor cells; (ii) high expressor: moderate to strong positivity (2+ to 3+) in ≥10% of tumor cells. The scoring system was based on cytoplasmic (BCAT1/BCAT2) or nuclear expression (HES1) of each marker and intensity scores were defined by comparison with positive controls (i.e. *NOTCH1* mutated PDX samples with high BCAT1 and HES1 expression documented in western blot). Specifically, strong (score 3+) positivity was attributed to cases with protein expression comparable to that of the positive controls, moderate (score 2+) positivity to cases with protein expression slightly fainter than controls, and weak (score 1+) positivity to cases with barely detectable protein expression.

Immunoprecipitation of acetylated proteins. Immunoprecipitation of acetylated proteins was performed using the Signal-seeker Acetyl-Lysine detection kit (Cytoskeleton, Inc., Denver, CO, USA) according to the manufacturer's recommendations. Briefly, cells were lysed in diluted BlastR lysis buffer containing class I and II HDAC inhibitor (Trichostatin A; TSA) and class III HDAC inhibitor (Nicotinamide). Approximately 2 mg of protein was pre-cleared with Protein G–agarose (Santa Cruz Biotechnology) at 4°C for 30 min before being incubated with Acetyl-lysine Affinity beads or Acetyl-lysine IP control beads overnight at 4°C. Beads were washed three times with BlastR-2 wash buffer and bound proteins eluted with bead elution buffer. Immune complexes were analyzed by SDS-PAGE and immunoblot.

Neutral comet assay. T-ALL cells were treated with vehicle (DMSO) or etoposide (1 μM) for 0 to 6h. The neutral comet assay was performed using the CometAssay Silver Kit (R&D Systems; #4251-050-K). Briefly, cells were

mixed with CometAssay LMAgarose (R&D Systems; 1:10[v/v]). Once the agarose had solidified, the cells were lysed with lysis solution (R&D Systems) overnight. The following day, we placed the slides briefly in neutral electrophoresis buffer (R&D Systems) before being placing them in an electrophoresis chamber containing neutral electrophoresis buffer. The slides were subjected to electrophoresis at 1V/cm for 1h at 4ºC. We washed the slides in 70% ethanol. After drying the slides at room temperature, we stained the comets with SYBR-gold (ThermoFisher Scientific, #S11494). We viewed the comets by epifluorescence microscopy. For comet analysis we used the Open Comet software[7] to quantify the percentage of DNA in the tail in at least 50 comets per condition.

Analysis of publicly available datasets. Expression data for BCAA metabolic genes in primary T-ALL patients and thymic subpopulations were obtained from GSE46170[8]. Microarray data were also obtained from GSE12948[9], GSE14959[10], E-MTAB-9279[1], CGAS00000000002[11], GSE33469[12], GSE33470[13]. RNA sequencing (RNA-seq) data of 264 pediatric T-ALL patients from St. Jude[14] was used. Gene expression data of B-cell chronic lymphocytic leukemia (B-CLL) patients analyzed with HGU133+2.0 Affymetrix GeneChip arrays (N = 107) was obtained from Gene Expression Omnibus (GSE22762)[15]. BCAT1 expression levels were extracted and used to generate Kaplan–Meier survival plots. The mean BCAT1 expression level was used as cut-off to define high and low BCAT1 expression.

RNA-sequencing and gene-set enrichment analysis. Total RNA from the spleens of ΔE-NOTCH1 leukemia-bearing WT and *Bcat1* KO C57BL/6 mice was extracted using the RNAeasy Mini Kit (Qiagen, Hilden Germany), according to the manufacturer's instructions. Library preparation and paired-end RNA sequencing using Illumina NextSeq 500, as well as downstream data analysis, were performed by Active Motif (Waterloo, Belgium). Sequenced reads were mapped to the genome using the STAR aligner with default settings and uniquely mapped reads were counted. Normalized counts per million and differential gene expression were determined with DESeq2. Hierarchical clustering of Z score and log fold-change expression values used in heatmaps was carried out using GenePattern software[16]. RNAseq data was also analyzed using iDEP[17]. Gene set enrichment analysis (GSEA) analysis was performed using gene sets from the Molecular Signature Database at the Broad Institute (https://www.gsea-msigdb.org/gsea/msigdb/index.jsp) as previously described[18] using GenePattern software. Primary data has been deposited in GEO (GSE267966) and will be released September 1 2024.

Steady state metabolite profiling. Spleens (N=3) and thymuses (N=2) from *ΔE-NOTCH1* leukemia bearing mice and thymic tissue from 6 weeks old normal C57/BL6 mice (N=3-5) were obtained. Flash-frozen tissue (spleen or thymus) was subsequently analyzed by Capillary Electrophoresis Time-of-Flight Mass Spectrometry (CE-TOFMS; Ω-scan analysis, HMT, Tokyo, Japan). For in vivo experiments, we analyzed flash-frozen tissue (spleen) from *ΔE-NOTCH1* leukemia bearing mice with WT (N=3) and *Bcat1* KO genotype (N=3) by CE-TOFMS (C-scope analysis, HMT, Tokyo, Japan). Further, *ΔE-NOTCH1* leukemia bearing mice (N=3 each) were injected intraperitoneally (i.p.) with three doses of ERG245 (30mg/kg), which is a potent BCAT1 inhibitor, at 8 h intervals or vehicle (PBS). Identification of known chemical entities was based on comparison to metabolomics library entries of purified standards and was performed by HMT. Heatmap representation of metabolites identified by CE-TOFMS in NOTCH1-induced (*ΔE-NOTCH1*) leukemia cells treated with vehicle (PBS) or ERG245, *ΔE-NOTCH1* tumors versus normal thymic tissue or *ΔE-NOTCH1* tumors WT versus KO for *Bcat1* was performed using MetaboAnalyst[19].

Stable-isotope tracing experiments. For the stable isotope-tracing experiments using primary cells, *ΔE-NOTCH1* leukemia bearing mice were injected i.p. with three doses of ERG245 (30mg/kg) at 8 h intervals or vehicle (PBS). Ten minutes before sacrifice mice were injected i.v. with $^{13}C_6$ Leu (Cambridge Isotope laboratories, Tewksbury, MA, USA) and spleens were flash-frozen. In another set of experiments, *ΔE-NOTCH1* leukemia bearing mice (WT and *Bcat1* KO) were injected i.v. with $^{13}C_6$ Leu (Cambridge Isotope laboratories) and spleens flash-frozen. Flash-frozen splenic tissue was subsequently analyzed by F-scope CE-TOFMS (HMT, Tokyo, Japan).

Analysis of ChIP-seq databases. The ChIP-seq data presented in this study were obtained from NCBI GEO under the following accession IDs: GSM959056 (HPB-ALL-NOTCH1)[20], GSM2521494 (MOLT4-PolII)[21], GSM4271227 (MOLT4-H3K4me3)[22] and GSM3693104 (ATACseq MOLT4)[23]. Fastq files from these public ChIPseq and ATACseq datasets were downloaded and mapped to human reference genome (GRCH38/hg38) using Bowtie2 (version 2.5.0)[24] with default parameters. MACS2 (version 2.2.7.1) [25] was used to call peaks. Next, Bedgraphs generated by MACS2 were converted to BigWig files with UCSC – wigtobigwig tool (version 357) and displayed using pyGenomeTracks (version 3.7) [26].

Cell viability assays and flow cytometry. We analyzed cell viability/proliferation in T-ALL cell lines via the bioluminescent method Vialight plus (Lonza, Basel, Switzerland) or by counting live cells after trypan blue staining. For assays evaluating the effects of drugs on T-ALL cell lines, viability was evaluated after 72h. In detail, human T-ALL cells (3×10^5) or mouse T-ALL cells (0.5×10^5) were seeded in 24-well flat-bottom plates and treated with increasing doses of the various compounds: Etoposide (50-500 nM), Cytarabine/Ara-C (25-100 nM), Doxorubicin hydrochloride (25-100 nM) all from Selleck (Selleck Chemicals LLC, Houston, TX), ERG245 (200-1000 μM; Ergon Pharmaceuticals, Washington DC, NW, USA). Dibenzazepine (DBZ; Syncom, Groningen, the Netherlands) was used in selected experiments. Dl-β-hydroxybutyrate (3-HB; sodium salt) and sodium butyrate (NaB) were from Sigma-Aldrich. We analyzed apoptosis after 48-72h by flow cytometry (FACS) after staining with Annexin V-FITC (Roche) or Annexin V-PE (BD Biosciences, Milan, Italy) and SYTOX Red dead cell stain (Invitrogen). Apoptosis was defined as the sum of the percentage of Annexin V^+ and Annexin V^+/ SYTOX Red^+ cells. Analysis of proliferation combined with cell cycle profile was performed using the Click-iT™ EdU Flow Cytometry Assay Kit (Life Technologies) according to the manufacturer's instructions. The samples were collected on a FACSCalibur (BD Biosciences) using Cell Quest software (BD Biosciences), and analysed with FlowJo (Tree Star Inc., Ashland, OR).

Plasmids, lentiviral constructs and viral production. For BCAT1 silencing experiments, HEK293T were transfected with pGipz non-silencing shRNA control, shBCAT1#1 (V3LH5-337223), shBCAT1#2 (V2LH5-64329) and appropriate packaging plasmids using JetPEI transfection reagent (Polyplus, Illkirch, France). Inactivation of human BCAT1 in T-ALL cells using the CRISPR-Cas9 technology was achieved using the guide sequence for BCAT1 (TATTAGGTCTTTAGCCTG; sgBCAT1)[27] which was cloned into LentiCRISPRV2 puro vector (Addgene #98290). BCAT1 over-expression was done using pLenti-BCAT1-Myc-DDK-P2A-Puro (RC219229L3; Origene, Rockville, MD, USA). Plasmids carrying the catalytic inactive mutant of BCAT1 (K222A) was synthesized and cloned in pLenti-Myc-DDK-P2A-Puro vector by Genewiz (ALENTA Life Sciences, Chelmsford, MA, USA). For viral production, viral supernatant from transfected cells was collected 48h after transfection, filtered and used to infect target cells. All infections of T-ALL cells were performed by spinoculation. After infection, T-ALL cells were selected for 3-7 days in puromycin before functional assays.

Luciferase reporter experiments. To perform reporter assays, BCAT1 promoter (-1407 to +195 relative to the TSS) was cloned into the pGL4.23[luc2/minP] vector (E841A, Promega, Madison, WI, USA) using Bgl II and Hind III restriction sites by Genewiz (ALENTA Life Sciences, Chelmsford, MA, USA). Constructs having the RBP-J binding site (TGGGAA) mutated or deleted were also generated. To measure the capacity of ICN1 transcription factor to induce BCAT1 expression, HEK293T cells were co-transfected with pGL4.23[luc2/minP] vector containing the above mentioned BCAT1 promoter (pGL4-BCAT1 promoter) and increasing amounts of pcDNA3-ICN1 (kind gift of A. Weng; Terry Fox Laboratory, BC Cancer Agency, Vancouver, Canada) and Renilla luciferase vector (Promega). In some experiments using HEK293T cells, pGL4-BCAT1 promoter construct with the RBP-J binding site (TGGGAA) mutated was used. To determine the effects of NOTCH1-inhibition on reporter activity, pcDNA3-ICN1 transfected cells were treated for 48h with increasing amounts of CB103 (Selleck). To evaluate the contribution of MYC to reporter activity, pcDNA3-ICN1 transfected cells were either transfected with MYC targeting hairpins (pLKO-shMYC#1 (TRCN0000039640), pLKO-shMYC#2 (TRCN0000174055)) or increasing amounts of the BRD4 inhibitor, JQ1 (Selleck). Experiments were repeated at least twice and performed at least in quadruplicate. Luciferase activity was measured 72h post-transfection by Dual-Glo Luciferase Reporter assay kit (Promega) according to the manufacturer's guidelines. For reporter assays in T-ALL cells, we resuspended 1.5 x 10^6 HPB-ALL cells in 20 µL of SF Nucleofector Solution (Lonza) with the addition of 700 ng of pGL4.23 vectors (BCAT1 promoter or control constructs) and 300 ng of pGL4.74 [hRluc/TK] Renilla luciferase reporter plasmid (Promega). Cells were electroporated (Amaxa Nucleofector; Lonza) using program CM130 and resuspended in 1 ml of RPMI / 20%FCS and incubated at 37°C/ 5% CO_2 for 48 hrs. In some experiments HPB-ALL cells were co-transfected with pcDNA3-ICN1 or treated with CB103. Experiments were repeated three times and performed at least in quadruplicate. Luciferase activity was measured 48-72h post-transfection by Dual-Luciferase Reporter assay kit (Promega). Relative luciferase activity was calculated as Firefly luciferase activity normalized against Renilla luciferase activity.

Mouse studies. NOTCH1-induced T-ALL tumors (generated using both *HD-ΔPEST* and *ΔE* alleles[1]) were secondarily transplanted intravenous (i.v.) into sub-lethally irradiated recipients (C57BL/6 females of 6-8 weeks). Tumor bearing mice were euthanized and primary tumor cells extracted from the spleens of leukemic mice. T-ALL PDX samples[4] were expanded in vivo via i.v. injection into female 6-8 weeks old NOD Rag1null IL2Rγ null immunodeficient mice (NSG mice; Charles River, Wilmington, MA, USA). Tumor bearing mice were euthanized and tumor cells extracted from the spleens of leukemic mice and used in functional assays. For the evaluation of BCAT1 function in vivo, we infected MOLT4 or CCRF-CEM control (shCTRL) or BCAT1 deficient (shBCAT1#1/ shBCAT1#2) leukemic cells with lentiviral particles expressing luciferase (FUW-Cherry-LUC) and injected them i.v. into NSG mice (5x10^6 cells/mouse; N=5 per experimental group). We evaluated disease progression by in vivo bioimaging with the In Vivo Imaging System (IVIS, Xenogen, Grantham, UK). In therapy related experiments, PDX leukemic cells (T-ALL#19 or T-ALL#27) were infected with lentiviral particles expressing luciferase (FUW-Cherry-LUC) and injected i.v. into 6–8-week-old female NSG mice. After tumor engraftment (human CD45+ blasts ≥1% in peripheral blood), we treated homogeneous groups of animals (N=5) with vehicle (DMSO/PBS), Etoposide (10 mg/kg or 15 mg/kg twice a week; intraperitoneal), ERG245 (30 mg/kg three times a week; intraperitoneal) or the combination Etoposide (10 mg/kg or 15 mg/kg twice a week; intraperitoneal) + ERG245 (30 mg/kg three times a week; intraperitoneal) for 10-15 days. We evaluated disease progression and therapy response by in vivo bioimaging with the In Vivo Imaging System IVIS Spectrum (Xenogen), spleen weight and human CD45 analysis by flow cytometry. Xenografted mice were age- and sex-matched and randomly assigned to groups. No blinding methods were used. Procedures involving animals and their care conformed with institutional guidelines and were authorized by local (OPBA) and national animal ethical committees (Italian Ministry of Health; DGSAF 0006112; 177/2020-PR).

BCAT1 promoter methylation testing by Methylation specific PCR (MSP). Genomic DNA was extracted from T-ALL cell lines (DNeasy kit, Qiagen) according to the manufacturer's instructions. A total of 500 ng of genomic DNA was bisulfite modified using EZ DNA Methylation™ Kit (Zymo Research, Irvine, CA, USA). Bisulfite modified DNA (20ng) was amplified with BCAT1 promoter specific primers (listed in *Online Supplementary Table S4*). A bisulphite-conversion specific actin beta (ACTB) PCR was performed (primers listed in *Online Supplementary Table S4*) to determine total amount of analyzed DNA. PCR conditions used are available upon request. PCR products were loaded on 2% agarose, stained with SYBR safe DNA gel stain (Thermo Fisher Scientific), and visualized under UV illumination.

Table S1: Primer sequences for amplification of BCAT1 promoter following ChIP

TARGET LOCI	DIRECTION	SEQUENCE (5' to 3')
BCAT1 ***P1***	FORWARD	CTCTGGGAAAGAGATCGGCA
BCAT1 ***P1***	REVERSE	CTGCATGCTGAGAGGACCAC
BCAT1 ***P2***	FORWARD	AATCTTCGGGCTGGGAGAGA
BCAT1 ***P2***	REVERSE	GCAGATCCCAAGGGTCGTAG
HES1 ***P1***	FORWARD	AAGTTTCACACGAGCCGTTC
HES1 ***P1***	REVERSE	GCTGTTATCAGCACCAGCTC
BCAT1 ***NL***	FORWARD	GTATCGCTCTGCTGTGAGGG
BCAT1 ***NL***	REVERSE	GTCAACACCGTGACCCGTTA

Table S2_Differentially expressed genes between Bcat1KO and Bcat1WT NOTCH1-dependent leukemias

Ensemble ID	Symbol	DETUMOR KO-DETUMOR_WT_log2FoldChange	DETUMOR KO-DETUMOR_WT_padj	DETUMOR_WT#0_1	DETUMOR_WT#0_2	DETUMOR_WT#0_3	DETUMOR_WT#6_1	DETUMOR_WT#6_2	DETUMOR_WT#6_3	DETUMOR_KO#7_1	DETUMOR_KO#7_2	DETUMOR_KO#7_3	DETUMOR_KO#3_1	DETUMOR_KO#3_2	DETUMOR_KO#3_3
ENSMUSG00000045010	Gm4779	10.64676018	6.46E-21	2.80947046	2.32265191	2.32279427	2	2.320152159	2	7.84426137	7.8406322	7.9512576	11.542683	11.497332	11.58069
ENSMUSG00000090015	Gm15446	7.217665549	1.55E-14	2	2.58616865	2	2	2	2	5.45829491	5.8780348	5.9514022	5.5837553	5.829622	6.207633
ENSMUSG00000046774	8030474K03Rik	6.937006211	1.12E-10	4.17376203	4.25078255	4.39582017	2.3198067	2.320152159	2.32024072	7.17869317	7.2143575	7.496925	10.834736	10.905635	10.83097
ENSMUSG00000031125	3830403N18Rik	6.836535449	1.38E-08	2.58660819	2	2	4.51477944	4.314811199	3.80131951	7.41663134	7.6533656	7.3008695	10.645245	10.687365	10.629257
ENSMUSG00000095574	Trbv12-1	6.774001762	1.21E-15	3.32488899	3.32409844	2.58640584	2.3198067	2.320152159	2.32024072	5.99882775	6.0397503	5.9279464	9.1124347	9.0759958	9.231708
ENSMUSG00000076465	Trbv5	6.574131389	6.64E-08	6.46413927	6.57331899	6.73208315	4.23953538	4.452152566	4.45251622	13.2868952	13.400864	13.28948	7.2655037	7.3974477	7.4738522
ENSMUSG00000076873	Trdv5	6.308259504	6.57E-17	3.70385559	3.70294367	3.46218583	3.31555453	3.900368117	3.57933023	6.6992374	6.6817489	6.2639549	10.216645	10.338571	10.242446
ENSMUSG00000086391	1700042O10Rik	6.12351583	5.55E-13	2.80947046	2	2.58640584	2.3198067	2.582001393	2	5.12817554	5.2050447	5.1266377	7.4249784	7.3003549	7.1780377
ENSMUSG00000018849	Wwc1	6.038304381	0.014249	2.58660819	2	2.32279427	2.3198067	2.320152159	2	6.7669798	6.7896504	6.9159751	2	2	2
ENSMUSG00000059256	Gzmd	5.92430055	2.22E-05	2	2	2	2	2	2	3.99906228	2.3209407	2.9985073	4.3912513	3.6980072	
ENSMUSG00000076472	Trbv15	5.073432964	1.20E-13	8.53235509	8.3655153	8.60790762	8.75764398	8.879916979	8.7925193	10.9874367	10.968046	11.026306	14.622336	14.622023	14.594324
ENSMUSG00000093954	Gm16867	4.994891262	1.78E-11	3.32488899	3.00180885	3.17232976	2.3198067	2.582001393	2.32024072	7.56863151	7.2713083	7.4889326	5.2842203	4.9969249	5.1275786
ENSMUSG00000102364	Ighv8-5	4.679381387	0.000424	2.32291573	2.32265191	2.32279427	5.41661938	5.60653695	5.34992256	6.35636259	6.3876093	6.5517291	10.012709	9.9287142	9.8372877
ENSMUSG00000069306	H4c17	4.567884131	0.0001886	2	2	2	2	2	2.58214912	3.32117796	4.2440258	3.805222	2.8067906	3.3198201	3.9054796
ENSMUSG00000039058	Ak5	4.565594415	0.0118454	2	2	2.58640584	2.3198067	2	2.8037367	5.55344488	5.6958767	5.7251591	2.3216648	2	2.3215434
ENSMUSG00000084997	Gm15471	4.065396929	5.95E-05	2.58660819	2.8089055	2.58640584	3.31555453	3.45377331	3.16523297	7.10731028	7.0826646	7.0845638	3.1691935	3.5826201	3.4582072
ENSMUSG00000022156	Gzme	4.029909245	0.0002217	2	2.32265191	2.58640584	2	2.320152159	2.58214912	2.80681915	3.1671805	3.5829719	5.2842203	4.4565564	5.042703
ENSMUSG00000036242	Armh4	3.932010222	0.0087328	3.00246783	2.32265191	2.32279427	2.80280525	2	2.58214912	6.0432195	5.8533786	5.6976827	2.3216648	2	2.8065305
ENSMUSG00000078161	Erich3	3.786469008	0.0037746	2	2.32265191	2.58640584	2.3198067	2.320152159	2	3.16923045	2.3209407	2.5839675	4.9057492	4.5206589	4.3203887
ENSMUSG00000034057	Myrfl	3.757288127	9.04E-06	3.32488899	2.8089055	2.32279427	2.3198067	2	2	4.16895254	4.0836837	3.805222	5.3563635	5.2822481	5.4576822
ENSMUSG00000031137	Fgf13	3.681374957	7.68E-05	2.80947046	2.58616865	2.58640584	2.58142511	2.582001393	2.32024072	3.45863601	3.9962936	2.5839675	5.7801385	5.4230771	5.5528283
ENSMUSG00000001672	Marveld3	3.650379111	0.0385308	2	2	2	2.3198067	2.320152159	2	2.99937492	3.4562874	3.9977603	2.8067906	2	2.3215434
ENSMUSG00000070732	Rbm44	3.519759705	2.29E-05	2	3.17193469	3.46218583	2.80280525	3.694282913	3.31686005	6.30259365	6.7231634	6.9159751	3.9059249	4.5820339	4.5219723
ENSMUSG00000015437	Gzmb	3.391219953	5.42E-35	3.32488899	4.0902284	3.91006404	4.79824119	4.577548304	4.38547538	7.75366023	7.2046433	7.5284591	7.1686446	6.939114	7.3379731
ENSMUSG00000020182	Ddc	3.373616911	1.67E-05	3.32488899	3.32409844	3.46218583	2.80280525	3.45377331	3.31686005	6.98747365	6.8025878	6.5970492	3.9059249	4.1671919	4.1684284
ENSMUSG00000040170	Fmo2	3.228087338	0.0058496	3.32488899	3.4617334	3.58784774	2.99469065	3.316593717	3.31686005	7.03221076	6.7765959	6.7520113	3.4585936	2.5837918	2.3215434
ENSMUSG00000023963	Cyp39a1	3.107736897	2.19E-50	5.00431594	4.70349952	4.70410076	4.5761027	4.452152566	4.24125532	7.63539933	7.7298587	7.8108474	7.2371226	7.3274893	7.2555137
ENSMUSG00000035686	Thrsp	3.094750268	0.0021854	3.32488899	3.00180885	2.32279427	2.99469065	3.316593717	2.32024072	5.99882775	5.8533786	5.9514022	2.9993416	3.4571958	3.1688562
ENSMUSG00000006014	Prg4	3.05306881	0.0042104	3.91050864	3.17193469	3.32452507	2.3198067	2.582001393	2.8037367	6.14856716	6.0828102	6.488999	3.1691935	3.4571958	2.9990381
ENSMUSG00000076492	Trbj2-1	3.045468074	0.0057546	8.02722352	8.09631967	8.05954318	5.44976368	5.576804784	4.69328731	7.72669362	7.7162491	7.8735809	11.192211	11.130276	11.084879
ENSMUSG00000019124	Scrn1	3.020547911	0.001713	3.91050864	2.58616865	3.58784774	2.80280525	2.803546666	2.99577786	6.52236591	6.4215511	5.9971999	3.321138	3.8048451	3.3207737
ENSMUSG00000063458	Lrmda	2.932944581	1.53E-06	3.8108791	3.17193469	3.00216447	2.80280525	3.16498644	3.69459039	4.39130525	5.124905	4.2455699	6.3910631	6.2254914	6.0205618
ENSMUSG00000038233	Gask1a	2.874848371	1.46E-07	2.80947046	2.58616865	3.00216447	2.80280525	3.45377331	2.58214912	4.32092783	4.5194791	4.2455699	5.6135004	4.9511354	5.1682145
ENSMUSG00000030587	2200002D01Rik	2.771071831	2.04E-30	4.09123546	4.17273779	4.00324548	3.79976415	3.579034195	3.45405584	6.26560109	6.1450822	6.488999	6.0431569	6.3542087	6.2269969
ENSMUSG00000020890	Gucy2e	2.763132983	6.70E-19	3.588252	3.5873738	5.0912803	3.99202864	3.801002232	3.69459039	6.68529867	6.5498556	6.4565805	6.5065355	6.371694	6.4575947
ENSMUSG00000045790	Ccdc149	2.754692054	0.0003357	4.00370016	3.4617334	4.00324548	3.16402452	3.45377331	3.31686005	4.08650672	3.9962936	4.2455699	6.7800906	6.4060416	6.7530343
ENSMUSG00000021747	Cfap20dc	2.700104024	0.0228972	4.39631085	4.3952449	5.133115	2.58142511	2.582001393	2.58214912	3.45863601	3.8038253	4.4569882	7.1983912	7.0626793	7.3110069
ENSMUSG00000058740	Kcnt1	2.697415794	0.0430233	3.32488899	2.32265191	3.17232976	2.3198067	2.803546666	2	5.49071386	5.2050447	4.7523434	2.9993416	2.3212258	2.5843213
ENSMUSG00000061451	Tmem151a	2.666964075	0.0199102	3.32488899	2.58616865	2.32279427	2.3198067	2.320152159	2	4.69938173	4.4553878	4.5824738	2.5845236	2.9982436	2.9990381
ENSMUSG00000095130	Ighv1-39	2.652023111	0.0385283	5.00431594	4.52654927	5.133115	8.4652151	8.409055326	8.47545387	11.0967839	11.028489	11.061088	7.7198071	7.6404116	7.7123577
ENSMUSG00000021587	Pcsk1	2.632350056	0.0001208	2.32291573	2.58616865	2.32279427	2.80280525	2.582001393	2.32024072	3.99906228	3.9032667	4.0851792	3.321138	3.8048451	3.8059806
ENSMUSG00000018727	Cpsf4l	2.525442675	4.38E-05	5.28982865	5.61803048	5.98133135	4.51477944	4.080660667	4.51657958	6.16874406	6.2620998	6.1870014	8.2081541	8.0839996	8.3644211
ENSMUSG00000102222	Pcdhga10	2.459578891	9.12E-07	2.58660819	3.4617334	2.58640584	2.58142511	3.316593717	3.16523297	4.45840862	4.3883165	4.0851792	4.9988477	4.9038448	5.0857649
ENSMUSG00000115970	8430426J06Rik	2.446152126	0.0038826	2	2.32265191	2	2.80280525	2.320152159	2.99577786	3.80646187	3.5816684	2.9985073	3.6995281	3.4571958	3.9054796
ENSMUSG00000076494	Trbj2-3	2.439532288	0.0346512	6.7729351	7.00350259	6.89899826	3.45267087	2.320152159	2.8037367	7.49063046	7.5187257	7.4317104	8.7833298	8.7480617	9.0987519
ENSMUSG00000047501	Cldn4	2.439420158	6.61E-08	7.86282756	7.83010029	7.86223222	5.89696396	5.968945122	5.79950395	9.56290567	9.5284125	9.5725679	9.6280462	9.5491729	9.6810795
ENSMUSG00000073535	Gm5532	2.430863336	5.35E-13	5.7324803	5.52686336	5.5585469	5.07808018	5.277416118	5.41859685	7.14853192	7.0175762	6.8919313	8.2513657	8.3184571	8.1879265
ENSMUSG00000041789	2700046A07Rik	2.397176181	6.67E-05	3.32488899	3.17193469	3.17232976	2.80280525	2.582001393	2.32024072	3.45863601	4.5808437	4.1676023	5.0863008	4.4565564	4.9525203
ENSMUSG00000066677	Ifi208	2.346690953	2.05E-30	6.55931079	6.19324212	6.15382946	5.57521373	5.418193514	5.74705896	8.42082892	8.4171786	8.3807531	8.133128	8.2397055	7.9523029
ENSMUSG00000022206	Npr3	2.325839848	0.0031753	3.91050864	4.00271242	4.09077189	3.45267087	3.900368117	3.99366215	3.69957415	4.2440258	4.0851792	6.6425919	6.6113385	6.7530343
ENSMUSG00000076525	Igkv1-99	2.306716522	0.0085073	4.86223324	4.86109829	4.32538969	6.32973889	6.785835982	6.79920113	6.10734654	6.2620998	6.0415883	9.120226	8.993692	8.9924441
ENSMUSG00000110998	I730028E13Rik	2.221283903	0.0127299	3.17266678	2.58616865	2.58640584	2.58142511	2.582001393	2.58214912	4.52252907	4.4553878	4.4613475	2.8067906	3.1679733	2.9990381
ENSMUSG00000035299	Mid1	2.212534186	1.04E-34	5.46391545	6.06948903	6.04845802	5.7974791	5.968945122	5.82502842	7.89963731	7.8899571	7.52064	8.1019899	8.3496749	8.1579738
ENSMUSG00000043773	1700048O20Rik	2.191387831	3.01E-08	6.46413927	5.91026528	6.17401072	6.84771084	6.677945629	6.957599	7.71987247	7.877783	7.7718547	9.1909848	9.3430204	9.1928455
ENSMUSG00000063600	Egfem1	2.180291399	0.0108327	2.58660819	2.8089055	2	2.3198067	2.582001393	3.69459039	4.45840862	4.4553878	4.4569882	3.1691935	3.5826201	3.8059806
ENSMUSG00000044206	Vsig4	2.178973525	0.0480083	3.46257176	3.70294367	3.91006404	3.45267087	2.803546666	3.31686005	5.92956893	6.3876093	5.6411084	3.4585936	2.5837918	2.8065305
ENSMUSG00000040181	Fmo1	2.153740582	0.0448616	2.80947046	3.17193469	2.32279427	2.80280525	2.995556056	2.99577786	4.75382239	4.9498913	5.1266377	2.5845236	2.9982436	2.5843213
ENSMUSG00000087556	Gm15764	2.153387043	6.63E-18	4.86223324	5.0475718	4.58856814	4.79824119	5.277416118	4.74768681	6.40819937	6.9259558	6.440094	6.8316192	7.2539649	7.2927453
ENSMUSG00000042385	Gzmk	2.09948026	4.86E-05	3.32488899	3.17193469	3.00216447	3.99202864	3.45377331	3.99366215	4.95310728	5.5500663	6.0415883	4.2468879	4.9038448	4.8057055
ENSMUSG00000073551	Spink13	2.08725879	0.0384967	2.80947046	2.32265191	2.58640584	2.3198067	2.582001393	2.8037367	4.58392055	3.5816684	4.0851792	2.5845236	3.3198201	2.5843213
ENSMUSG00000052430	Bmpr1b	2.085421857	0.0361004	3.32488899	4.0902284	3.46218583	3.45267087	3.316593717	3.80131951	3.16923045	3.9962936	2.5839675	5.7801385	6.2634544	6.1067116
ENSMUSG00000059089	Fcgr4	2.054893663	1.77E-06	8.77967355	8.88316802	8.70472388	9.31135653	9.185916183	9.31126854	11.7245433	11.746606	11.710833	9.99021	9.9851836	9.8807267
ENSMUSG00000006642	Tcf23	2.043836649	0.0181576	3.32488899	3.17193469	3.32452507	2.80280525	2.582001393	2.32024072	4.52252907	4.9026068	5.2067896	3.4585936	3.1679733	3.1688562
ENSMUSG00000041608	Entpd3	2.042986086	0.032195	3.46257176	2.58616865	2.32279427	2.3198067	2.320152159	2.99577786	4.39130525	3.9962936	4.6413475	2.5845236	3.5826201	3.3207737
ENSMUSG00000020481	Ankrd36	2.01792237	0.0058397	6.21411868	6.1326921	6.37915695	5.63407184	5.664223877	5.12179534	8.70612067	8.6061315	8.6835426	5.6712117	5.9036102	6.0642797
ENSMUSG00000038305	Spats2l	2.017381088	0.0297183	4.75908943	4.17273779	4.17329055	5.63407184	5.77310734	5.63607788	7.95877159	7.9199501	7.8797067	4.6993254	4.5820339	4.9052229
ENSMUSG00000020681	Ace	1.982492872	1.47E-12	10.0231126	9.91648979	9.89609121	8.77736088	8.705428935	8.83396759	11.5851219	11.547732	11.554959	11.389929	11.257998	11.346807
ENSMUSG00000008845	Cd163	1.978349202	0.0006192	8.04377556	7.93429357	7.63359505	8.35143528	8.470978687	8.43458431	10.7825692	10.896688	10.959192	8.6097212	8.4311539	8.5294778
ENSMUSG00000076490	Trbc1	1.911096199	0.0251135	11.7140094	11.7543182	11.7995488	12.6162182	12.58286024	12.5861067	11.5050589	11.479382	11.468692	15.022784	15.032487	15.026716
ENSMUSG00000045551	Fpr1	1.890132585	0.0039771	5.93534593	5.61803048	5.83691257	5.84807889	6.014015574	5.69263533	8.35191169	8.4708451	8.4233125	5.806132	5.7781007	6.0205618
ENSMUSG00000047592	Nxpe5	1.872796349	1.99E-08	5.7324803	5.75823544	5.86200878	6.09850501	5.945870649	6.40133334	8.26555235	8.219124	8.3144631	7.043117	7.0626793	7.117072
ENSMUSG00000030474	Siglece	1.84370694	0.0015283	7.98213323	8.2275688	8.107550667	7.57454663	7.442513572	7.42636765	10.3419391	10.44525	10.369887	8.1072265	7.99654	8.1829773
ENSMUSG00000021187	Tc2n	1.843530107	0.0230554	3.17266678	3.17193469	3.17232976	3.31555453	3.45377331	3.31686005	5.24680876	5.0400503	5.4235559	2.9993416	2.9982436	3.9985569
ENSMUSG00000028444	Cntfr	1.825073705	0.028657	5.13365172	5.32518239	4.52713629	4.38371152	4.992214091	4.51657958	7.4825933	7.4381134	7.0739172	4.3208746	4.3894726	4.7532483
ENSMUSG00000004885	Crabp2	1.821040293	0.0312778	2.32291573	2.58616865	3.00216447	2.58142511	2.582001393	2.99577786	2.58454581	3.5816684	2.9985073	4.0864558	4.0847757	4.0859914
ENSMUSG00000101389	Ms4a4a	1.789361019	0.0005933	5.55910126	5.32518239	5.36145625	6.52897969	6.515048508	6.77321143	8.57240989	8.4748918	8.2402265	6.8316192	7.1962531	6.6275099
ENSMUSG00000051439	Cd14	1.759368146	0.0054447	6.21411868	6.36099128	6.43038954	6.6045073	6.898286583	6.94601321	9.0782436	9.1397493	8.9942159	6.5378985	6.7647985	6.6275099
ENSMUSG00000015224	Cyp2j9	1.75825452	0.0317202	3.00246783	3.00180885	3.58784774	2.99469065	2.803546666	2.8037367	3.99906228	2.9975301	2.9985073	4.2468879	4.5206589	5.2462057
ENSMUSG00000005131	4930550C14Rik	1.75709698	0.0009812	6.00462373	5.95757876	6.11259974	5.69062254	5.692224792	5.51584262	8.14342549	8.1849485	8.2778222	6.2466798	6.2445977	6.1681075
ENSMUSG00000028546	Elavl4	1.756052708	1.54E-05	4.00370016	4.00271242	3.58784774	2.99469065	3.579034195	3.31686005	5.55344488	5.2050447	4.9515951	4.8568457	4.7518938	4.4578572
ENSMUSG00000055170	Ifng	1.746855991	0.0295625	2.58660819	3.17193469	2.32279427	2.3198067	2.582001393	2.8037367	3.45863601	3.8038253	2.9985073	4.0864558	2.9982436	3.6991077
ENSMUSG00000001864	Aif1l	1.743265365	0.0491135	6.21411868	6.61817789	6.17401072	5.69062254	5.635668724	5.74705896	5.32080275	5.0831014	5.4235559	8.5378559	8.6830197	8.5792962
ENSMUSG00000028957	Per3	1.731367816	5.95E-05	6.41409069	6.41283643	6.11259974	6.0774525	5.968945122	5.99207333	6.61351047	7.0612931	6.8172978	8.4865377	8.4803401	8.3379493
ENSMUSG00000039956	Mrap	1.701963363	0.0012114	6.0707267	5.73126334	5.67641223	6.43279603	6.561329904	6.66430124	8.55335173	8.5147463	8.536204	6.7800906	6.7515029	6.5217212
ENSMUSG00000051359	Ncald	1.692570501	4.24E-08	5.46391545	5.17313917	5.3962317	5.27585864	5.201516736	5.34992256	6.35636259	6.2241389	6.3009452	7.3385655	7.186406	7.4493306
ENSMUSG00000068606	Gm4841	1.683355491	0.0002166	3.00246783	3.32409844	3.32452507	2.80280525	3.579034195	3.31686005	3.80646187	4.5808437	4.6413475	4.7537657	4.4565564	4.1684284
ENSMUSG00000050439	Enthd1	1.677045481	0.0166117	4.46346769	4.3952449	3.46218583	3.45267087	3.900368117	3.80131951	4.16895254	4.3883165	3.9047007	6.2082076	5.9274531	5.8808491
ENSMUSG00000000982	Ccl3	1.633805855	1.05E-09	4.00370016	4.58797599	4.17329055	4.07933474	4.692911159	4.31516673	5.78020026	5.4549378	5.3192401	5.9987653	5.9036102	5.9523961
ENSMUSG00000020811	Wscd1	1.630098733	0.0008134	6.29008118	6.00338973	6.49598681	6.0344028	5.922421116	5.85010914	6.61351047	6.5030684	6.520705	8.4825135	8.2011039	8.2601955
ENSMUSG00000079597	Cstdc4	1.624287397	0.0058219	2.80947046	2.32265191	2.32279427	3.45267087	3.45377331	3.31686005	4.39130525	4.2440258	3.9977603	4.0864558	3.9043138	3.6991077
ENSMUSG00000048899	Rimkla	1.61221484	0.0369047	3.17266678	2.8089055	3.00216447	2.58142511	4.240904489	3.57933023	4.08650672	3.5816684	3.5829719	4.7537657	4.9511354	5.2462057
ENSMUSG00000111354	Gm33914	1.607062325	0.0244665	2.80947046	3.17193469	3.17232976	3.31555453	2.320152159	2.32024072	4.32092783	3.5816684	4.3898999	3.4585936	3.8048451	3.3207737
ENSMUSG00000044927	H1f10	1.601457821	0.0315886	4.86223324	5.0906534	4.91064028	4.79824119	4.240904489	4.45251622	4.52252907	4.6397044	4.4569882	6.9760047	6.8420975	7.042528
ENSMUSG00000020090	Npffr1	1.585630454	0.0297166	4.64799974	5.36081511	5.04819618	2.99469065	3.45377331	3.31686005	5.04329531	5.2809661	5.0848276	6.1485043	6.3004439	6.3380206
ENSMUSG00000025934	Gsta3	1.552956359	0.0395583	4.81158291	4.70349952	4.86171081	4.89767527	5.48374496	5.45174579	7.22760162	7.0612931	7.4808956	4.64275	4.9038448	4.8057055
ENSMUSG00000005237	Dnah2	1.547511161	0.0261657	5.13365172	5.2511628	5.3258218	5.82300082	6.181412124	5.85010914	7.812553	7.8899571	7.8674288	5.4906532	5.6691864	5.3201962
ENSMUSG00000048215	A630023P12Rik	1.543025338	0.0421628	5.2138525	5.2511628	4.81106345	4.79824119	5.079611326	4.57791872	4.39130525	5.0831014	4.4569882	7.1072456	7.1361362	7.2172957
ENSMUSG00000047678	Gpr82	1.516011032	0.0255605	3.32488899	3.17193469	3.91006404	3.57787902	3.694282913	2.99577786	5.24680876	4.7506771	5.3896152	3.6995281	3.5826201	3.9054796
ENSMUSG00000035448	Ccr3	1.513961505	0.0018557	8.08700782	8.14311557	8.07035042	8.70027006	8.71910307	8.68162345	10.5408175	10.572498	10.608968	8.7668794	8.7811518	8.719193
ENSMUSG00000095788	Sirpb1a	1.509829569	0.0001637	5.7324803	5.55789694	5.86200878	5.27585864	5.746647149	5.48415014	7.64263078	7.5029595	7.5969875	6.1485043	6.1464304	6.3380206
ENSMUSG00000079076	Gm3086	1.503018624	0.014786	3.32488899	3.70294367	3.32452507	4.23953538	4.452152566	4.38547538	5.92956893	5.8780348	5.3192401	4.2468879	4.8043426	4.1684284
ENSMUSG00000079507	H2-Q1	1.497217623	2.38E-07	7.91173999	7.79145263	7.71848894	6.64799599	6.772782753	6.73332735	9.01556751	9.1010005	8.8888219	8.6604741	8.5814842	8.7123394
ENSMUSG00000030711	Sult1a1	1.493655249	0.0221983	7.06006581	6.89831182	6.63350779	7.18932456	7.002602482	7.32267092	9.28646995	9.2781762	9.1942501	6.7800906	7.0078214	6.6563633
ENSMUSG00000034220	Gpc1	1.488692394	0.0005159	6.95896894	7.22268701	6.87454274	7.8904072	7.712366832	7.75988327	8.1125098	8.0931604	7.8735809	9.4601699	9.3973853	9.5584186
ENSMUSG00000025885	Myo5b	1.487409412	0.0174422	5.17430934	5.13248572	5.28928485	4.38371152	3.99332894	3.69459039	5.04329531	5.3530911	4.9515951	6.7536193	6.7647985	6.3904846
ENSMUSG00000120321	Gm51802	1.48033752	2.37E-07	5.09181499	5.003164	4.09077189	4.99069578	5.079611326	4.99260313	6.50659919	6.4871292	6.6695556	5.7801385	5.9739884	5.9289391
ENSMUSG00000026712	Mrc1	1.477744609	7.03E-05	10.4153683	10.2727304	10.3890965	10.9097366	10.90101003	10.87344	12.6214886	12.694415	12.671869	11.253123	11.308806	11.23887
ENSMUSG00000033508	Asprv1	1.441381434	7.01E-05	3.17266678	3.4617334	3.32452507	4.16165755	3.801002232	4.16335188	5.04329531	4.7506771	4.6413475	5.1281166	4.8043426	4.8057055
ENSMUSG00000022181	C6	1.441208548	0.000603	8.87525409	8.81736453	8.85603734	9.07424874	9.107506694	9.06842175	11.001567	10.996474	11.017304	9.3273661	9.4803205	9.2625306
ENSMUSG00000004709	Cd244a	1.438883559	6.67E-05	6.5438785	6.17333981	6.23291401	6.21874975	5.824614865	5.96936166	8.05946424	8.0612192	8.0469067	6.9175898	6.7245383	6.8054992
ENSMUSG00000020682	Mmp28	1.434731634	0.0261657	4.46346769	4.00271242	4.58856814	3.89909685	3.694282913	4.24125532	6.12810407	6.1450822	5.7251591	4.64275	4.1671919	4.0859914
ENSMUSG00000091971	Hspa1a	1.408500479	0.0004426	3.8108791	3.00180885	3.91006404	3.89909685	3.694282913	3.80131951	5.04329531	5.1655312	5.1266377	4.64275	4.3191168	4.3907597
ENSMUSG00000042961	Egflam	1.395983545	0.0299155	5.75945423	5.13248572	5.75889322	5.19996894	4.992214091	5.27781519	7.27490625	7.3874914	7.4889326	5.1281166	5.4886509	5.2836752
ENSMUSG00000018930	Ccl4	1.393347675	1.37E-05	4.09123546	3.4617334	4.17329055	3.6930831	4.516212395	4.08100044	5.12817554	5.0831014	5.3896152	5.3563635	4.7518938	5.3905763
ENSMUSG00000059657	Stfa2l1	1.383826498	0.049347	3.00246783	2.8089055	2	3.6930831	3.694282913	3.57933023	4.39130525	4.2440258	4.5210949	3.4585936	4.4565564	3.8059806

ENSMUSG00000015854	Cd5l	1.372277129	0.0112117	11.0547707	11.0690248	11.0575647	10.2771082	10.28689573	10.2987709	12.7625851	12.749111	12.771802	10.834736	10.819064	10.810257
ENSMUSG00000054072	Iigp1	1.356089732	9.06E-30	8.04925097	8.3478669	8.4921176	8.19407762	8.120508951	8.01957931	9.73515736	9.6586386	9.6957321	9.2933121	9.4311336	9.4819021
ENSMUSG00000078190	Dnm3os	1.351121881	0.031713	4.25182216	4.0902284	3.81044603	4.94493511	4.850310455	4.74768681	6.20827055	6.5498556	6.0846517	4.4583541	4.9038448	4.5833589
ENSMUSG00000062380	Tubb3	1.347486732	4.97E-08	6.83764871	6.91038566	6.7456312	7.18932456	7.598611844	7.36678712	8.75364865	8.8989793	8.6336677	8.0967343	7.9390567	8.1928587
ENSMUSG00000025355	Mmp19	1.346021271	0.000798	5.75945423	6.1326921	5.86200878	6.61914967	6.450935812	6.515474	8.12288881	7.9551375	8.1107984	6.806085	6.6831222	6.8310331
ENSMUSG00000035042	Ccl5	1.319536213	0.0004292	5.17430934	5.36081511	5.91092831	6.23785108	6.483348273	6.38426458	7.72669362	7.6245127	7.6117839	6.7536193	6.8545874	6.6275099
ENSMUSG00000015947	Fcgr1	1.313112517	0.0007776	6.61944034	6.64732718	6.67658164	6.95548763	7.024794002	7.16170391	8.68175632	8.591297	8.7519282	7.2178869	7.4228316	7.2460537
ENSMUSG00000030087	Klf15	1.308463239	0.0238154	5.32636716	5.55789694	4.70410076	5.16047261	5.349521258	5.03696515	7.22760162	6.9838967	6.962893	5.3563635	5.2822481	5.1275786
ENSMUSG00000102748	Pcdhgb2	1.298948604	0.0313441	3.70385559	2.8089055	2.58640584	3.31555453	4.080660667	2.99577786	4.39130525	3.9962936	4.0851792	3.9990123	4.8043426	4.0859914
ENSMUSG00000063415	Cyp26b1	1.279844905	0.0041252	5.7324803	5.46271875	5.86200878	6.0774525	5.968945122	6.079505	7.76695684	7.6317802	7.5669316	6.0648508	6.1464304	6.3200999
ENSMUSG00000027954	Efna1	1.267903381	0.0437339	5.75945423	5.83625203	5.73192013	5.07808018	4.946446378	3.99366215	5.55344488	5.7233502	5.2827219	7.1983912	7.0409858	7.117072
ENSMUSG00000071716	Apol7e	1.265367583	4.31E-07	6.95896894	6.73139962	6.60406041	5.71808778	5.968945122	6.2208143	7.91165967	7.8716573	7.4808956	7.3824188	7.5664147	7.6491655
ENSMUSG00000095028	Sirpb1b	1.25418795	0.023827	4.25182216	4.58797599	4.52713629	4.69144319	4.992214091	5.24036336	6.24674292	6.6246128	6.3894728	5.3207428	4.5206589	4.9525203
ENSMUSG00000078922	Tgtp1	1.247814368	0.0002397	7.03820412	7.13279528	7.08101331	6.75793781	6.785835982	6.78626481	7.46638339	7.4463804	7.3721245	8.6097212	8.6149063	8.6985338
ENSMUSG00000079018	Ly6c1	1.246490667	3.57E-05	7.94148901	7.8364421	7.86223222	7.59691102	7.506993378	7.44294829	9.40176898	9.4108268	9.3257065	8.3296162	8.1863578	8.3947032
ENSMUSG00000045502	Hcar2	1.233419489	0.0009736	6.86274267	7.10154208	7.26160061	6.84771084	6.719355744	6.99180835	8.76363266	8.6208151	8.7009453	7.3824188	7.3003549	7.4410633
ENSMUSG00000005413	Hmox1	1.226379242	0.0079159	11.6839656	11.7148479	11.7060601	11.7074791	11.75887927	11.7745512	13.5835951	13.57814	13.57279	11.808854	11.796175	11.831363
ENSMUSG00000078780	Gm5150	1.223223821	0.003342	5.9114938	5.75823544	5.95824332	5.87272847	5.692224792	5.72010376	7.5986882	7.378879	7.5745045	6.0431569	6.0627843	6.2649621
ENSMUSG00000069792	Wfdc17	1.206534765	7.84E-05	7.81219846	7.8364421	7.79866373	8.8032378	8.66361126	8.68511223	9.84581235	9.791118	9.9248033	9.1124347	9.1411681	9.1013773
ENSMUSG00000062661	Ncs1	1.205531226	0.0303741	4.52763697	4.81045442	4.32538969	4.94493511	4.577548304	4.24125532	4.45840862	4.85372	4.804795	6.0862233	6.0841549	6.4575947
ENSMUSG00000117485	Gm19696	1.199230674	7.82E-05	3.91050864	4.25078255	4.17329055	3.57787902	4.314811199	4.38547538	5.35642361	4.85372	5.1266377	4.9057492	5.0843618	5.3558154
ENSMUSG00000106438	Gm32051	1.19244001	0.0313241	7.49667514	7.6473994	7.51993112	6.97838265	7.181167553	6.96909248	9.16868325	9.1849145	9.1133785	7.2081719	7.3094565	7.2075809
ENSMUSG00000028967	Errfi1	1.188126433	0.0002816	6.7596366	6.3957609	6.47986499	7.05576959	7.09988163	6.89871662	8.48660354	8.4171786	8.2778222	7.2933373	7.4641701	7.2742496
ENSMUSG00000030088	Aldh1l1	1.177837161	0.0001262	5.58948364	5.64718272	5.4633646	6.55966682	6.746316554	6.45136042	7.12806832	7.1347479	7.0951324	7.498558	7.263363	7.6054453
ENSMUSG00000073555	Gm4951	1.174891247	1.54E-05	6.02699627	5.93411597	6.66236611	6.48168928	6.450935812	6.65009068	7.88751393	7.9435035	7.7181689	6.8567094	7.1764912	7.2835271
ENSMUSG00000004359	Spic	1.170911007	0.0113104	9.46842793	9.63477427	9.50414772	9.64941038	9.557199537	9.62458126	11.3974951	11.357555	11.325132	9.5986026	9.7090288	9.5924101
ENSMUSG00000027488	Snta1	1.162500152	0.0065175	5.7324803	5.93411597	5.73192013	6.23785108	6.100140376	5.92283673	7.64982615	7.6245127	7.5284591	6.1686812	6.2820677	6.1479311
ENSMUSG00000021453	Gadd45g	1.160929726	1.82E-30	8.53235509	8.61090871	8.70125159	8.33378902	8.417466959	8.10540797	9.57618494	9.5668347	9.5573617	9.6189095	9.6812507	9.6828335
ENSMUSG00000047798	Cd300lf	1.156608499	0.0014401	7.52052367	7.70398571	7.3261458	7.84752678	7.824145038	7.61376735	9.26554423	9.301149	9.3212122	7.9412189	8.0733527	8.00373
ENSMUSG00000057378	Ryr3	1.154887553	0.0229388	4.95849239	4.32482117	4.86171081	4.7458302	4.577548304	4.63675592	6.10734654	5.8780348	6.6118449	5.0863008	4.5206589	5.1275786
ENSMUSG00000056486	Chn1	1.15453982	0.0008282	3.588252	3.5873738	3.81044603	4.23953538	3.900368117	3.80131951	4.80628319	4.7506771	5.0848276	4.5838651	4.5820339	4.6422398
ENSMUSG00000023913	Pla2g7	1.154129381	0.0207044	8.90273562	8.88316802	8.88998554	9.69504523	9.605853781	9.4591968	11.0835603	10.953619	11.087793	9.3385411	9.3995178	9.3109706
ENSMUSG00000066363	Serpina3f	1.151086701	0.0001003	7.16466507	6.88613607	6.96997176	7.98388262	7.957025524	8.28627212	8.75364865	8.9463808	8.8643174	8.7232093	8.7514051	8.6201469
ENSMUSG00000022257	Laptm4b	1.144331724	0.0026227	7.51261788	7.51923634	7.47996206	6.89660817	6.649663449	6.89871662	7.53015807	7.6533656	7.6765515	8.7865975	8.8699591	8.7260141
ENSMUSG00000024529	Lox	1.140649138	0.0056506	5.95881011	6.2128736	6.17401072	6.46557494	6.759610343	6.4676579	7.83797521	8.0878858	8.0026841	6.5837004	6.7108646	6.6705764
ENSMUSG00000072720	Myo18b	1.136985479	0.0001606	4.3258746	5.21267838	5.1737707	4.79824119	4.314811199	4.80010939	6.10734654	5.8533786	6.1469286	5.8567548	5.4562365	5.4245194
ENSMUSG00000052957	Gas1	1.134132543	0.0391585	4.00370016	4.70349952	4.86171081	4.89767527	4.850310455	5.03696515	5.95302658	6.3876093	6.5517291	4.7537657	4.9969249	4.9052229
ENSMUSG00000035873	Pawr	1.133034895	0.0131976	3.91050864	4.32482117	5.04819618	4.84881472	5.036574414	5.66463374	5.64270583	5.6393084	5.1672702	6.1686812	6.2820677	6.3557215
ENSMUSG00000087384	Gm15558	1.118865945	7.46E-08	6.49656573	6.51125134	6.88682232	6.97838265	7.17125377	6.89871662	8.21793488	8.2094419	8.1619616	7.6207615	7.5815208	7.6491655
ENSMUSG00000050493	Fam167b	1.118621793	0.0155165	5.46391545	6.41283643	5.95824332	5.66262426	5.451341511	5.45174579	7.54567078	7.378879	7.0845638	5.9987653	6.1259691	6.0205618
ENSMUSG00000081219	Bambi-ps1	1.115384027	0.0003126	9.35141493	9.35674017	9.43892895	8.44069483	8.49899114	8.63187329	9.68700594	9.7195933	9.6282052	10.480486	10.419611	10.501907
ENSMUSG00000030148	Clec4a2	1.113191806	0.0243288	7.24320577	7.22268701	7.16407621	8.31592423	8.166147644	8.22527572	9.49860236	9.3916902	9.4747881	8.0210711	8.0463867	8.026011
ENSMUSG00000032942	Ucp3	1.110666621	0.0103659	5.52806525	5.13248572	5.00378569	5.38269568	5.12140151	5.08000365	6.84428313	6.8154103	6.5517291	5.2842203	5.6114821	5.5218049
ENSMUSG00000032246	Calml4	1.10835106	0.0027511	4.25182216	3.8099383	4.46297179	3.79976415	3.801002232	3.45405584	5.12817554	4.9498913	5.0417695	4.8568457	4.6974661	4.3907597
ENSMUSG00000114369	Gm41077	1.10047964	0.0166682	5.86257288	5.88601365	6.25202586	6.44927858	6.220393213	5.99207333	7.73348268	7.7960448	7.6835716	6.0862233	6.4229134	6.2649621
ENSMUSG00000055150	Zfp78	1.09595329	0.0050803	3.588252	3.70294367	4.17329055	3.57787902	3.900368117	3.57933023	4.32092783	4.2440258	4.5210949	4.9057492	4.9511354	4.6422398
ENSMUSG00000052270	Fpr2	1.094051639	0.0301596	5.04872871	5.0475718	5.52751202	4.7458302	5.546446959	5.48415014	6.6992374	7.0504874	6.6695556	5.2467492	5.520353	5.4245194
ENSMUSG00000016529	Il10	1.09271069	0.0150737	5.67697062	5.70377736	5.5585469	6.71768502	6.499285457	6.38426458	7.61348494	7.7699336	7.6835716	6.5223022	6.5044343	6.4411076
ENSMUSG00000075410	Prcd	1.091847333	0.0398543	3.70385559	3.32409844	3.00216447	3.16402452	3.579034195	3.31686005	3.80646187	3.4562874	3.9977603	4.3912513	4.4565564	4.3907597
ENSMUSG00000085795	Zfp703	1.074170266	1.38E-07	8.93858183	8.79148531	8.71853007	8.33822086	8.409055326	8.38396172	9.99875445	9.8898946	9.9857095	9.2631341	9.3737167	9.3731265
ENSMUSG00000026018	Ica1l	1.073411635	5.39E-06	5.7324803	5.73126334	5.81137207	4.94493511	5.036574414	5.03696515	6.49065826	6.6246128	6.4565805	6.1686812	6.4229134	6.3904846
ENSMUSG00000021710	Nln	1.068732402	5.48E-08	9.50674147	9.42985919	9.44931575	9.71221977	9.633194774	9.75811119	10.9161242	10.970914	11.004046	10.178597	10.325171	10.251929
ENSMUSG00000026011	Ctla4	1.066366487	0.0007163	6.29008118	6.55805062	6.66236611	6.79709791	6.886216252	6.6212426	7.12806832	7.0612931	7.0305273	8.0539852	8.1258183	8.1529207
ENSMUSG00000058818	Pirb	1.065180033	0.0186079	9.08171058	9.05887072	8.89303249	8.95234329	9.03008527	9.00841711	10.6417069	10.655064	10.696593	8.9557956	9.0188799	9.0802388
ENSMUSG00000031298	Adgrg2	1.063693991	0.0452246	5.64839374	5.64718272	5.58892821	5.1198645	5.12140151	5.03696515	6.9760692	6.9609988	6.9159751	5.3207428	5.6114821	5.2462057
ENSMUSG00000027962	Vcam1	1.063222666	0.0092361	12.6237726	12.6127919	12.6749793	13.0407456	13.06624736	13.0813287	14.4697263	14.47079	14.499286	13.01375	13.039343	13.021311
ENSMUSG00000021567	Nkd2	1.060530853	0.009618	5.70499242	5.67575754	5.52751202	5.41661938	5.384265947	5.48415014	5.88147742	5.5804312	5.8552002	7.1280036	7.1155274	6.8054992
ENSMUSG00000038702	Dsel	1.057716783	0.0107457	5.04872871	5.42954425	5.36145625	5.99002889	6.239495772	5.82502842	6.16874406	5.7767759	6.3721965	7.0099511	7.3094565	7.0093625
ENSMUSG00000050105	Grrp1	1.056746936	0.0029387	4.86223324	5.003164	4.52713629	5.07808018	5.664223877	5.48415014	6.0432195	6.40468	6.6695556	5.699224	5.520353	6.0856516
ENSMUSG00000016458	Wt1	1.055317726	0.03369	5.49634687	5.75823544	5.75889322	5.19996894	5.384265947	5.41859685	7.10731028	7.0504874	7.0523854	5.6712117	5.3891376	5.6129426
ENSMUSG00000070369	Itgad	1.05107292	0.0429154	10.6577642	10.5427645	10.6051567	10.2561829	10.25674244	10.2595279	12.1315717	12.165924	12.111409	10.256075	10.311646	10.285794
ENSMUSG00000038007	Acer2	1.049573575	0.0053738	6.66294795	6.61817789	6.8496655	7.07713855	7.220155162	7.22058818	8.52624013	8.506863	8.385066	7.2178869	7.3003549	7.2269456
ENSMUSG00000032554	Trf	1.048039018	2.03E-06	10.9349194	10.86547	10.8739103	11.3638739	11.3370717	11.3811873	12.5070404	12.512237	12.495864	11.830388	11.776208	11.767502
ENSMUSG00000074677	Sirpb1c	1.046595026	0.0204598	4.3258746	4.64689376	4.58856814	4.7458302	4.850310455	5.24036336	6.32074021	6.1450822	5.9514022	5.0432368	5.166801	4.8563221
ENSMUSG00000059498	Fcgr3	1.045287348	0.0116492	9.31778344	9.22033702	9.29201043	10.5031185	10.36833577	10.4993613	11.4276349	11.423423	11.412759	10.482502	10.499327	10.472801
ENSMUSG00000050503	Fbxl22	1.040489959	0.0002225	6.66294795	6.61817789	6.39643742	6.9322234	6.691881486	6.86219799	8.1586384	8.0449794	8.089814	7.0321462	7.1764912	7.3556745
ENSMUSG00000037161	Mgarp	1.027190649	0.0263374	3.70385559	3.5873738	3.32452507	3.6930831	4.163006272	3.45405584	4.69938173	4.5194791	4.8554064	3.9059249	3.9973646	4.5219723
ENSMUSG00000075010	AW112010	1.026573344	0.0018557	9.29261232	9.36553726	9.32397078	10.2289956	10.19325252	10.2571859	11.2063762	11.24477	11.222225	10.458118	10.354048	10.378542
ENSMUSG00000037095	Lrg1	1.025607307	0.0157834	8.91478359	8.98658046	8.86226945	8.61152191	8.541940407	8.51911228	10.319554	10.372281	10.291643	8.9499783	8.6969586	8.886835
ENSMUSG00000046727	Cystm1	1.02496406	0.0231213	5.09181499	5.13248572	5.00378569	5.19996894	5.384265947	5.57721245	6.78015477	6.6817489	6.6118449	5.6712117	5.2063188	5.3201962
ENSMUSG00000008540	Mgst1	1.019282618	0.0121948	7.52052367	7.27030818	7.37054319	8.40311487	8.502948884	8.49148293	9.44996783	9.4338765	9.4064215	8.3780772	8.4436086	8.6310901
ENSMUSG00000020325	Fstl3	1.017436059	0.0391495	7.71219636	7.55043265	7.61894739	7.33835186	7.467032452	7.60642626	9.21792648	9.1725098	9.1133785	7.3562671	7.4803794	7.5603587
ENSMUSG00000001240	Ramp2	1.010163658	0.0367043	7.17471969	7.36107936	7.17413071	6.78416229	6.515048508	6.59180588	8.50655795	8.591297	8.4564786	7.1686446	7.0300155	6.8310331
ENSMUSG00000032549	Rab6b	1.009936775	0.0083023	7.08160117	7.06959683	7.18411563	6.0344028	6.057720555	5.38466829	7.53793528	7.5725886	7.5516655	7.5761394	7.7514377	7.5830781
ENSMUSG00000034271	Jdp2	1.006194766	0.0056562	6.4804436	6.55805062	6.75905321	7.7174836	7.642327755	7.60642626	8.5495097	8.5875644	8.4316758	7.7535949	7.848295	7.8246579
ENSMUSG00000014782	Plekhg4	-1.002047603	0.0354224	6.30846291	6.37848083	6.44707059	5.74503992	5.162015167	5.54685383	4.39130525	4.7506771	4.4569882	5.2082788	5.8547087	5.3201962
ENSMUSG00000036466	Megf11	-1.006170142	0.0029387	4.52763697	5.2511628	4.91064028	5.41661938	5.515436574	5.60694538	4.39130525	4.4553878	4.1676023	4.1689007	4.4565564	4.6422398
ENSMUSG00000079177	Fam228a	-1.009192353	0.0155034	4.81158291	5.49514752	5.25179848	4.4507334	5.277416118	4.51657958	4.58392055	3.8038253	4.2455699	4.3912513	3.6980072	4.1684284
ENSMUSG00000073538	E330020D12Rik	-1.009735519	0.0317202	4.91116549	4.32482117	4.17329055	5.16047261	4.850310455	4.89956435	2.99937492	3.9032667	4.0851792	3.6995281	4.3894726	4.2464084
ENSMUSG00000036698	Ago 2	-1.010235082	0.0024135	12.3807817	12.2288199	12.3208867	11.0378687	11.11264793	11.0710438	10.805302	10.807244	10.779199	10.777584	10.871474	10.834919
ENSMUSG00000050600	Zfp831	-1.017519654	0.0117188	5.81193468	5.83625203	6.13336188	7.16956531	7.07882382	7.12106866	5.92956893	5.6393084	5.2827219	5.6135004	5.6114821	5.9523961
ENSMUSG00000021680	Crhbp	-1.024015514	0.0041341	6.89958372	6.77166724	6.7985859	7.50529491	7.475113678	7.46746735	5.67127302	5.5804312	5.5822247	6.7129787	6.5044343	6.6563633
ENSMUSG00000020427	Igfbp3	-1.024875406	0.0429154	7.49667514	7.64016747	7.6115674	9.30684125	9.34870483	9.36445956	7.74023993	7.6245127	7.8858067	7.8252547	7.5279426	7.5830781
ENSMUSG00000076757	Trgc4	-1.028128608	1.89E-05	10.0533997	10.1457097	10.005717	10.8285888	10.83110894	10.8133361	9.2106463	9.2781762	9.1288913	9.700862	9.7909167	9.5868002
ENSMUSG00000070498	Tmem132b	-1.033112273	0.0033765	9.04655323	9.06967768	8.85915676	10.218216	10.23430183	10.1838651	8.8284833	8.8899154	8.9512334	8.4581296	8.4763047	8.5216584
ENSMUSG00000045410	Akr1e1	-1.046014034	0.0003015	7.24320577	7.4129214	7.28033863	8.00633488	7.830458128	8.06313181	6.8567737	6.9377316	7.0951324	6.4581745	5.9274531	6.3904846
ENSMUSG00000058881	Zfp516	-1.046216297	0.0009318	7.45603003	7.59599763	7.48804495	8.56312098	8.68118283	8.54238058	7.20823674	6.9494121	6.9513058	7.117662	7.1258686	7.3818259
ENSMUSG00000098799	Trgj4	-1.046454164	0.0090191	5.67697062	5.81071241	6.04845802	7.11894976	7.06817852	6.84981676	5.32080275	5.2050447	5.5518563	5.699224	5.829622	5.6986634
ENSMUSG00000076433	Cep295nl	-1.047520521	0.0201876	4.46346769	4.58797599	4.91064028	4.79824119	4.850310455	3.90069389	3.45863601	3.5816684	3.3201366	4.0864558	4.3191168	3.8059806
ENSMUSG00000096255	Dynlt1b	-1.060851286	1.16E-76	9.70187525	9.71268199	9.66786249	9.80158651	9.681139592	9.77621664	8.70266514	8.5838221	8.6190952	8.6569075	8.7974165	8.6563061
ENSMUSG00000077797	Snord19	-1.061848137	0.0341019	5.13365172	5.49514752	5.133115	4.38371152	4.314811199	3.99366215	3.99906228	3.8038253	3.9977603	3.5840846	4.3191168	4.0859914
ENSMUSG00000047880	Cxcr5	-1.064520704	0.0204923	6.34453832	6.41283643	6.63350779	6.78416229	6.677945629	7.02522529	4.95310728	5.0400503	4.4569882	6.3206769	5.8040913	6.3557215
ENSMUSG00000041779	Tram2	-1.072895597	0.0078559	5.88724069	5.86134738	5.83691257	6.75793781	6.957168369	7.01417209	4.80628319	5.3530911	5.520835	5.5837553	6.0190694	5.3201962
ENSMUSG00000072941	Sod3	-1.078507638	0.0043155	8.2384857	8.28897136	8.11800549	9.53245077	9.620500096	9.58030203	7.83166153	7.8899571	8.0026841	7.9412189	8.099824	8.127386
ENSMUSG00000028392	Bspry	-1.090888793	0.0025105	4.95849239	5.46271875	4.86171081	6.01238644	5.898584129	5.72010376	4.75382239	4.6397044	4.2455699	4.9057492	4.5820339	4.3203887
ENSMUSG00000025026	Add3	-1.098223881	0.0006749	8.49271663	8.57722471	8.5892432	9.73087858	9.675890398	9.73304995	8.37380407	8.2988995	8.2258716	8.0485514	7.9390567	8.020473
ENSMUSG00000030849	Fgfr2	-1.101099672	0.0397708	3.91050864	3.32409844	4.39582017	4.23953538	4.452152566	4.63675592	3.45863601	3.3189638	3.805222	3.4585936	2.9982436	3.4582072
ENSMUSG00000116895	Gm3435	-1.104863387	0.0001102	5.81193468	5.81071241	5.75889322	5.63407184	5.635668724	4.94683362	4.16895254	4.85372	4.8554064	4.3208746	4.7518938	4.8057055
ENSMUSG00000025558	Dock9	-1.1054027	0.026321	9.43744485	9.44860956	9.59301789	8.22790785	7.939610206	8.12094751	7.14853192	7.1850163	7.3807889	8.3474273	8.2957377	8.2648871
ENSMUSG00000040183	Ankrd6	-1.106314699	5.44E-07	7.9935386	7.81090587	7.88076912	8.52475219	8.587380424	8.64267941	6.89360938	6.9609988	7.1869195	7.3910318	7.4559966	7.2075809
ENSMUSG00000054999	Naaladl1	-1.108587165	0.0404492	7.27159011	7.35225497	7.2330292	5.7974791	5.77310734	5.45174579	6.06491344	5.9022768	5.752122	5.2467492	5.166801	5.5528283
ENSMUSG00000025461	Scart1	-1.108745535	0.0003814	10.2972374	10.1647347	10.1515154	10.4219345	10.3930709	10.5374958	8.60978716	8.4586366	8.5477917	9.7094957	9.6385543	9.7378651
ENSMUSG00000067586	S1pr3	-1.113544677	1.15E-09	6.02699627	6.09086585	6.17401072	6.52897969	6.366568068	6.27738043	5.20833817	5.4217814	5.1266377	5.1687544	5.2447829	5.1682145
ENSMUSG00000036863	Syde2	-1.118046865	0.028335	6.27146222	6.88613607	6.75905321	5.44976368	5.719692575	5.31431933	4.95310728	5.2050447	3.9977603	5.3911259	5.4230771	5.5528283
ENSMUSG00000023267	Gabrr2	-1.126869128	0.0347622	3.8108791	3.5873738	4.09077189	4.89767527	4.577548304	4.38547538	3.45863601	3.3189638	3.1682663	3.4585936	3.5826201	3.8059806
ENSMUSG00000041193	Pla2g5	-1.137787203	0.0283189	5.64839374	5.42954425	4.81106345	6.52897969	6.663873842	6.73332735	5.55344488	5.3530911	5.2827219	4.8062261	4.8043426	4.4578572
ENSMUSG00000032207	Lipc	-1.149288633	0.0102117	4.70461358	4.3952449	4.32538969	4.16165755	3.801002232	4.74768681	3.45863601	3.1671805	3.805222	3.6995281	3.4571958	3.5836798
ENSMUSG00000025207	Sema4g	-1.162333469	0.0085103	6.69124078	6.81084139	6.88682232	7.82243903	8.046515082	7.9224197	5.61356153	5.6958767	6.0415883	6.6134466	6.9154646	6.7123944
ENSMUSG00000115762	Gm34907	-1.164551125	0.0041252	5.17430934	4.32482117	4.46297179	4.5761027	4.452152566	4.38547538	3.45863601	3.8038253	3.805222	3.321138	3.8048451	3.9054796
ENSMUSG00000025780	Itih5	-1.169037412	0.0103638	9.17482226	9.16598155	9.10232625	8.06098283	8.166147644	7.87433013	6.61351047	6.9609988	6.9159751	8.0539852	7.9680847	8.0315279
ENSMUSG00000112963	Gm6093	-1.17462309	1.39E-06	5.88724069	6.25135289	6.46356097	5.60494292	5.799090957	6.03645139	4.8569031	4.7506771	5.2067896	5.1281166	4.9511354	4.8563221
ENSMUSG00000076606	Igkj3	-1.178496227	0.0333932	4.46346769	4.70349952	4.09077189	5.69062254	5.799090957	5.51584262	3.69957415	3.9032667	4.0851792	4.0864558	4.3894726	4.7532483
ENSMUSG00000070469	Adamtsl3	-1.180814461	0.0036128	4.3258746	4.81045442	4.52713629	5.23841273	4.992214091	5.12179534	3.45863601	3.4562874	3.9047007	4.4583541	3.9043138	4.0859914
ENSMUSG00000041538	H2-Ob	-1.182047064	0.0014073	8.00485452	7.89837251	7.89299604	8.15943499	8.335504181	8.19133107	5.95302658	6.3351506	6.1057108	7.3995936	7.4144198	7.5138174
ENSMUSG00000052912	Smarca5-ps	-1.187443277	0.0464673	4.00370016	3.9095428	4.39582017	3.79976415	3.579034195	3.57933023	2.32167809	3.4562874	3.3201366	3.321138	2.9982436	3.1688562
ENSMUSG00000105703	Gm43305	-1.194371428	0.0420977	10.2634814	10.2360244	10.2827612	10.2863119	10.24969357	10.2976318	7.55336503	7.5343214	7.7586194	9.7931048	9.7312112	9.8498329
ENSMUSG00000030660	Pik3c2a	-1.198278445	7.82E-05	8.60850717	8.49943045	8.65891885	9.76254971	9.727542183	9.62276317	8.27953643	8.0175001	8.1819295	8.037622	7.9738208	7.8746252
ENSMUSG00000003379	Cd79a	-1.199569947	0.0020327	8.00485452	8.24197234	8.14381578	8.98379888	9.049157112	9.01119943	6.71304274	7.0175762	6.6836297	7.7996065	8.0299617	7.8746252
ENSMUSG00000020363	Gfpt2	-1.200350147	0.023477	5.9114938	6.06948903	6.15382946	5.16047261	5.036574414	5.20191333	4.16895254	3.9032667	3.9047007	5.553384	4.4565564	4.8563221
ENSMUSG00000024793	Tnfrsf25	-1.214167915	0.0403755	4.00370016	3.8099383	3.32452507	3.99202864	3.900368117	3.45405584	2.80681915	3.3189638	2.9985073	2.9993416	2.8058495	3.1688562
ENSMUSG00000026866	Kynu	-1.218912651	0.0302815	5.13365172	5.36081511	5.36145625	6.96698055	6.910256766	6.92255873	4.80628319	4.9498913	4.7523434	5.6712117	5.4230771	5.3905763
ENSMUSG00000074607	Tox2	-1.227760288	2.38E-05	8.10289166	8.16847203	8.12320462	8.96958585	8.945366698	8.86198054	6.98747365	7.0175762	6.86748	7.7469003	7.5815208	7.7596622

ENSMUSG00000051379	Flrt3	-1.232971136	0.048264	3.70385559	4.00271242	4.58856814	5.07808018	5.036574414	4.57791872	2.99937492	3.3189638	3.805222	2.9993416	4.3894726	3.8059806
ENSMUSG00000024617	Camk2a	-1.247272209	0.0144383	8.51663015	8.4298382	8.41790296	6.92044908	6.836898977	6.957599	6.61351047	5.9022768	5.9971999	7.0099511	6.996595	7.0315573
ENSMUSG00000060275	Nrg2	-1.247618156	1.70E-16	7.09224949	7.14306434	7.12314247	7.50529491	7.258116828	7.59904762	6.32074021	6.0397503	6.0632807	6.0648508	6.1052135	5.9981959
ENSMUSG00000045441	Gprin3	-1.256048284	0.0004124	5.25234065	4.64689376	4.81106345	5.38269568	5.079611326	4.85069372	4.58392055	3.9032667	3.9977603	3.9059249	3.9043138	3.4582072
ENSMUSG00000054672	Scart2	-1.272668525	0.0227143	5.61923936	5.88601365	5.88667588	7.57454663	7.779162544	7.68519417	5.85681683	6.0828102	5.8798588	5.699224	5.6114821	5.7261413
ENSMUSG00000027718	Il21	-1.275021283	0.0223871	4.46346769	4.0902284	5.00378569	5.1198645	5.515436574	5.45174579	3.32117796	3.9962936	3.1682663	3.8064143	4.4565564	4.5833589
ENSMUSG00000057777	Mab21l2	-1.27816786	0.0037991	4.81158291	4.95734574	5.04819618	4.23953538	4.38511559	4.16335188	2.99937492	3.5816684	3.5829719	3.8064143	3.6980072	4.0859914
ENSMUSG00000028051	Hcn3	-1.28126743	0.0083073	6.58968881	6.30721334	6.44707059	5.41661938	5.48374496	5.24036336	4.32092783	3.9032667	4.5824738	5.2467492	5.166801	5.3558154
ENSMUSG00000027408	Cpxm1	-1.283883948	0.0041451	8.78952164	8.60720465	8.71853007	10.3633465	10.31192685	10.3903122	8.47449705	8.1499437	8.2544399	8.6816904	8.4883772	8.7429273
ENSMUSG00000020310	Madcam1	-1.292966516	0.0003175	5.39677993	5.91026528	5.3962317	6.36491562	6.383840938	6.23991717	4.45840862	5.1655312	5.2067896	5.0863008	4.1671919	4.6422398
ENSMUSG00000118012	Gm46620	-1.298518976	1.75E-34	9.22406693	9.17851613	9.15658017	8.90233964	8.948272285	8.80219052	7.80612683	7.5725886	7.8108474	7.7198071	7.7380178	7.8989746
ENSMUSG00000078866	Zfp970	-1.309978376	0.0007998	7.26219058	7.59599763	7.45543808	9.01181164	8.642238916	8.71272291	6.64265579	6.7896504	6.9396248	7.1585912	7.0189611	7.301905
ENSMUSG00000069516	Lyz2	-1.313206334	0.0285637	11.5479567	11.5310875	11.6259142	12.9519016	13.14370405	13.1057775	10.1395838	10.077223	10.176932	11.807246	11.867624	11.720031
ENSMUSG00000041670	Rims1	-1.313804088	0.0064784	7.14434313	7.38723323	7.45543808	6.29368298	6.120891544	6.05813879	5.04329531	5.124905	4.7523434	5.9760466	5.9274531	6.2649621
ENSMUSG00000089774	Slc5a3	-1.314438799	0.0052008	7.20446983	7.2129712	7.50407612	8.86903562	9.03008527	8.84648499	6.61351047	6.5951731	6.9513058	7.2275368	7.3974477	7.2555137
ENSMUSG00000073008	Gpr174	-1.316685634	0.030136	5.43073817	4.86109829	4.32538969	6.17977121	5.968945122	5.96936166	3.80646187	3.5816684	3.9977603	4.5224741	4.7518938	5.2836752
ENSMUSG00000031024	Denn2b	-1.320914846	0.022538	10.0561218	10.1199464	10.0930981	7.98388262	8.15612975	8.18148407	8.50258909	8.4087421	8.4646524	7.3995936	7.7176509	7.7794702
ENSMUSG00000053846	Lipg	-1.322042432	1.99E-05	7.83139318	7.69703261	7.8180301	7.05576959	7.161271392	7.23017273	5.69928551	5.7767759	5.6119669	6.7266531	6.6970601	6.3904846
ENSMUSG00000028064	Sema4a	-1.324243544	0.0009344	7.19462112	7.2129712	7.14375451	8.67596589	8.602214522	8.64267941	6.78015477	6.8407184	6.8172978	6.7800906	6.5202	6.9981357
ENSMUSG00000078653	Cntd1	-1.325042391	4.70E-08	5.64839374	5.49514752	5.75889322	5.44976368	5.313919113	5.60694538	4.39130525	3.9032667	4.4569882	4.64275	4.5206589	4.3907597
ENSMUSG00000018554	Ybx2	-1.326498048	0.0087525	8.02722352	8.16343627	8.23308679	6.6045073	6.450935812	6.74674493	5.99882775	5.7503104	5.6411084	6.7800906	6.7380836	6.4075571
ENSMUSG00000060924	Csmd1	-1.32672121	0.0056076	4.46346769	4.00271242	4.17329055	4.7458302	4.850310455	5.12179534	3.80646187	3.8038253	4.0851792	3.321138	3.1679733	3.1688562
ENSMUSG00000028459	Cd72	-1.333080415	1.10E-08	7.00477759	7.02587214	6.98146849	7.29341274	7.09988163	7.29553879	6.14856716	5.9022768	6.2825686	5.5837553	4.9038448	5.9050945
ENSMUSG00000037341	Slc9a7	-1.338289669	0.0001139	6.8874076	6.96928416	6.94669973	7.3646584	7.712366832	7.49952437	5.45829491	5.1655312	5.4567164	6.5685941	6.4723766	6.1681075
ENSMUSG00000028979	Masp2	-1.339868048	0.0102041	4.00370016	4.46239037	4.75857317	3.57787902	3.99332894	4.08100044	3.16923045	3.1671805	2.9985073	3.5840846	3.4571958	3.1688562
ENSMUSG00000002007	Srpk3	-1.342083403	0.0046419	5.46391545	5.28864725	4.75857317	4.5761027	4.314811199	4.74768681	3.45863601	4.3883165	3.1682663	3.4585936	3.9973646	4.1684284
ENSMUSG00000022865	Cxadr	-1.342835717	0.0017599	7.35353879	7.44647592	7.05947822	7.27503768	7.576246893	7.35807114	5.04329531	5.1655312	5.1266377	6.7401992	6.6548359	6.4900142
ENSMUSG00000041649	Klf8	-1.35750279	0.0016501	5.36200308	5.83625203	5.6478363	7.05576959	6.772782753	6.79920113	4.8569031	5.3174793	4.8554064	5.0432368	5.6114821	4.9525203
ENSMUSG00000030724	Cd19	-1.360341068	0.0236231	8.58230872	8.41296389	8.43890399	8.48932556	8.598520272	8.67110618	5.5224203	5.4217814	6.1870014	7.8628917	7.9034343	7.9523029
ENSMUSG00000024347	Psd2	-1.364066944	0.0099983	5.39677993	5.64718272	5.04819618	4.51477944	5.036574414	4.51657958	3.32117796	3.3189638	3.3201366	4.5224741	4.5820339	4.0859914
ENSMUSG00000085876	Gm12409	-1.374251358	0.0126768	4.75908943	4.32482117	5.133115	5.34795505	4.747308112	4.74768681	2.80681915	3.3189638	2.9985073	4.3208746	4.2451532	4.2464084
ENSMUSG00000056602	Fry	-1.385397548	5.13E-22	8.48060956	8.32999992	8.07035042	8.38180623	8.31763913	8.29543144	6.80614917	6.750127	6.5517291	7.0648115	7.1962531	7.2649121
ENSMUSG00000031362	Xlr4c	-1.390301011	4.79E-07	5.88724069	5.70377736	5.3962317	5.89696396	5.77310734	5.54685383	4.75382239	3.4562874	4.4569882	4.64275	4.7518938	4.5219723
ENSMUSG00000024402	Lta	-1.39237647	0.0276214	4.25182216	4.25078255	3.91006404	5.34795505	4.899179037	5.38466829	4.32092783	3.4562874	2.5839675	3.6995281	3.9973646	3.5836798
ENSMUSG00000024910	Ctsw	-1.397046538	0.0287701	5.7324803	5.2511628	5.3962317	7.60428944	7.491141583	7.67820854	5.45829491	5.3878451	5.2067896	5.4582344	5.9036102	5.8808491
ENSMUSG00000033590	Myo5c	-1.397770734	0.0242525	3.70385559	4.0902284	4.00324548	5.27585864	4.899179037	5.34992256	3.99906228	2.9975301	3.805222	3.6995281	3.8048451	3.1688562
ENSMUSG00000008193	Spib	-1.407857816	0.0002512	7.78620165	7.69703261	7.76579731	7.82243903	7.677772279	7.69906478	5.24680876	5.6958767	5.520835	6.9645094	7.0189611	6.7663305
ENSMUSG00000016918	Sulf1	-1.416982019	1.85E-05	5.58948364	5.73126334	6.23291401	6.52897969	6.663873842	6.66430124	4.80628319	5.4549378	5.2067896	5.0863008	4.8043426	4.3907597
ENSMUSG00000033805	Ephx4	-1.421924487	0.0053192	5.04872871	5.0475718	5.1737707	6.73122779	6.620815729	6.63573874	4.69938173	5.0400503	4.7523434	4.5838651	4.5206589	5.0857649
ENSMUSG00000088088	Rmrp	-1.422219324	0.0186829	5.32636716	5.98066607	5.5585469	4.79824119	4.946446378	3.69459039	3.69957415	3.4562874	3.4575315	4.3912513	4.6409042	4.0859914
ENSMUSG00000115420	Rmrp	-1.422219324	0.0186829	5.32636716	5.98066607	5.5585469	4.79824119	4.946446378	3.69459039	3.69957415	3.4562874	3.4575315	4.3912513	4.6409042	4.0859914
ENSMUSG00000021047	Nova1	-1.427812318	0.0250481	3.46257176	3.5873738	4.00324548	4.4507334	3.900368117	4.16335188	3.32117796	2.3209407	2.9985073	3.1691935	3.5826201	2.5843213
ENSMUSG00000071984	Fndc1	-1.443217626	0.0283793	4.25182216	3.9095428	3.17232976	3.99202864	3.900368117	4.16335188	3.32117796	2.3209407	2.3213312	3.1691935	3.4571958	3.1688562
ENSMUSG00000046634	Pkd1l1	-1.446006125	0.020162	6.34453832	6.2128736	6.21354557	5.31235716	4.946446378	4.51657958	4.80628319	5.3174793	4.3898999	3.4585936	4.3894726	3.6991077
ENSMUSG00000021803	Cdhr1	-1.457045945	0.0393785	3.91050864	4.32482117	3.58784774	4.89767527	5.036574414	5.12179534	3.32117796	2.5833164	2.9985073	3.1691935	4.1671919	4.0859914
ENSMUSG00000019852	Arfgef3	-1.462056759	0.0019183	6.30846291	6.11193055	5.52751202	5.87272847	6.201034321	6.31389544	3.80646187	3.4562874	4.5210949	4.9530493	5.4562365	5.3201962
ENSMUSG00000054679	Srsf12	-1.462581494	0.0350073	4.00370016	3.8099383	3.32452507	3.99202864	4.240904489	4.85069372	2.99937492	2.3209407	3.805222	3.321138	3.1679733	2.8065305
ENSMUSG00000096780	Tmem181b-ps	-1.468695733	7.19E-103	10.3712387	10.3176208	10.4305779	10.4498479	10.3994544	10.3502204	9.07557443	8.9950948	9.0468841	8.7767721	8.7876797	8.8435823
ENSMUSG00000057337	Chst3	-1.481816547	0.0051232	7.37985225	7.09097207	7.24261601	6.6045073	6.957168369	6.77321143	4.45840862	4.1660812	4.8554064	6.265538	5.9739884	6.4575947
ENSMUSG00000076608	Igkj5	-1.481857805	0.0101061	4.91116549	4.81045442	5.0912803	6.58971479	6.635311692	6.81202249	4.24694042	4.3883165	4.804795	4.8568457	4.7518938	5.1275786
ENSMUSG00000029370	Rassf6	-1.497243503	0.0033329	5.13365172	4.81045442	4.58856814	6.05608822	5.77310734	5.45174579	3.45863601	3.3189638	4.1676023	4.7537657	4.5206589	3.9985569
ENSMUSG00000094094	Igkv5-45	-1.503224865	0.0003327	6.94728585	6.78484383	7.24261601	8.20382462	8.348759273	8.20111131	6.06491344	5.6101701	5.8045815	6.8567094	6.4560766	6.6275099
ENSMUSG00000074024	4632427E13Rik	-1.506004073	0.0183732	3.91050864	5.2511628	4.52713629	3.57787902	4.240904489	4.45251622	3.32117796	3.1671805	2.3213312	3.5840846	3.6980072	3.5836798
ENSMUSG00000042474	Fcmr	-1.510012	0.0297783	5.64839374	6.1326921	5.83691257	4.38371152	4.577548304	4.16335188	3.45863601	3.1671805	3.805222	4.9530493	3.9973646	4.2464084
ENSMUSG00000034981	Parm1	-1.516062967	2.43E-06	7.71908319	7.52709889	7.82442821	8.57443542	8.462874201	8.51911228	6.35636259	6.1450822	6.0415883	7.2178869	7.0409858	6.892958
ENSMUSG00000064158	Izumo1	-1.523137007	0.0361956	3.00246783	3.5873738	3.46218583	3.57787902	3.694282913	3.80131951	2.80681915	2.9975301	3.1682663	2.5845236	2.3212258	2.3215434
ENSMUSG00000026193	Fn1	-1.527794932	5.47E-08	10.3200656	10.1735279	10.1854631	11.1574255	11.17970253	11.2028376	8.94127424	8.8279895	8.9743167	9.5183264	9.5278855	9.5641397
ENSMUSG00000027797	Dclk1	-1.529314777	5.82E-10	6.09210467	6.1326921	6.23291401	5.96731941	6.120891544	5.79950395	3.69957415	4.6397044	4.5824738	4.8568457	5.0843618	4.9052229
ENSMUSG00000042812	Foxf1	-1.533342238	0.0130082	3.588252	3.9095428	4.09077189	4.51477944	4.38511559	4.31516673	3.69957415	3.3189638	3.5829719	2.3216648	2.8058495	2.5843213
ENSMUSG00000064080	Fbln2	-1.539246571	0.0313241	8.54791047	8.50342142	8.5278407	11.103774	10.98192901	11.0968125	9.26554423	9.2069778	9.1769427	8.0647918	8.078686	8.127386
ENSMUSG00000031292	Cdkl5	-1.545843638	0.0457337	5.58948364	5.49514752	5.73192013	3.57787902	3.45377331	4.38547538	3.584129	3.1671805	3.3201366	4.3912513	3.5826201	4.0859914
ENSMUSG00000076569	Igkv5-39	-1.565061512	0.010356	8.68436352	8.73829115	8.67316823	11.1359492	11.11781883	11.0836553	8.85984723	8.5458557	8.7249617	8.9235063	8.8102975	8.9258693
ENSMUSG00000079173	Zan	-1.56993609	0.0459818	5.93534593	5.58827699	6.13336188	4.89767527	4.850310455	5.12179534	2.32167809	3.5816684	2.9985073	4.8568457	4.6974661	4.8057055
ENSMUSG00000022123	Scel	-1.57409529	0.0017336	4.52763697	4.75796789	4.09077189	5.03504949	5.239965497	5.12179534	3.16923045	3.5816684	2.5839675	3.6995281	4.1671919	3.9985569
ENSMUSG00000030468	Siglecg	-1.576620035	1.87E-05	7.4226688	7.48735052	7.69772918	6.74464461	6.898286583	6.6783732	5.42513069	5.124905	4.7523434	6.3562992	6.1052135	5.8561893
ENSMUSG00000009628	Tex15	-1.580594204	1.66E-08	6.83764871	6.99218639	7.28033863	7.77091554	7.732732257	7.67820854	5.45829491	5.3174793	5.752122	6.3206769	6.1464304	6.1880056
ENSMUSG00000029095	Ablim2	-1.589055844	0.0056401	7.27159011	6.74494743	7.24261601	5.27585864	5.546446959	4.89956435	5.08635957	5.0400503	5.3548567	4.64275	4.9511354	4.8057055
ENSMUSG00000056529	Ptafr	-1.597460561	0.0015283	5.81193468	5.55789694	5.04819618	7.23757017	7.120636493	7.14152935	5.12817554	4.9026068	4.9515951	5.0432368	5.2447829	5.2077371
ENSMUSG00000020937	Plcd3	-1.60036753	1.33E-13	6.36224328	6.51125134	6.21354557	6.89660817	6.705684016	6.56175601	5.45829491	5.2809661	4.9043022	5.0863008	4.5820339	4.9983162
ENSMUSG00000030577	Cd22	-1.604452806	6.74E-13	9.09765252	9.03976153	8.97870593	9.34697881	9.315334646	9.27004742	7.17869317	7.1244806	6.9971065	7.9987036	8.0244449	7.8684732
ENSMUSG00000094117	Igkv3-12	-1.607569239	0.037529	8.14441297	8.19339053	8.07572383	11.002705	10.60675078	10.9971844	7.8253201	7.7162491	7.6624078	8.9673603	8.9737929	8.9839326
ENSMUSG00000097352	C920009B18Rik	-1.612446157	0.0014582	5.13365172	5.67575754	5.133115	7.03407934	6.933903235	6.89871662	4.8569031	4.5194791	4.8554064	4.9530493	5.2063188	4.8563221
ENSMUSG00000029811	Aoc1	-1.614272543	0.0149563	3.46257176	4.0902284	3.91006404	4.38371152	4.747308112	4.80010939	2.58454581	3.3189638	2.9985073	2.5845236	3.9973646	3.1688562
ENSMUSG00000040899	Ccr6	-1.61646799	0.0185146	6.02699627	5.61803048	6.04845802	5.03504949	5.576804784	5.66463374	3.45863601	2.3209407	3.805222	4.9057492	5.2447829	4.3203887
ENSMUSG00000106734	Gm20559	-1.616720988	0.0006346	8.20943584	8.24674175	8.10229472	9.99643047	10.01903859	10.0167155	7.86913567	7.9140012	8.1366068	7.5836729	7.4722975	7.5294986
ENSMUSG00000039521	Foxp3	-1.619415414	0.0004575	4.58907321	4.58797599	4.58856814	4.79824119	4.850310455	4.38547538	3.16923045	2.5833164	3.1682663	3.6995281	3.1679733	4.2464084
ENSMUSG00000000903	Vpreb3	-1.628298865	0.0320876	4.64799974	4.52654927	4.81106345	5.544859	5.874346668	6.01443299	2.80681915	2.5833164	3.4575315	4.5224741	4.6974661	4.5219723
ENSMUSG00000076755	Trgv1	-1.633286157	2.74E-20	8.17478807	8.0369833	8.11278755	8.44069483	8.487052342	8.42626961	6.32074021	6.5802249	6.3894728	7.0755376	7.0626793	6.5527463
ENSMUSG00000017167	Cntnap1	-1.638540103	0.0045214	5.95881011	5.83625203	5.73192013	7.8904072	7.642327755	7.83718088	5.32080275	5.2809661	4.9515951	5.6712117	5.9036102	6.0205618
ENSMUSG00000069305	H4c18	-1.650618054	0.0124387	4.95849239	4.70349952	5.04819618	4.31342374	4.452152566	2.99577786	3.584129	3.5816684	3.4575315	2.5845236	2.8058495	3.6991077
ENSMUSG00000032327	Stra6	-1.65982315	2.15E-06	5.04872871	5.13248572	4.46297179	5.23841273	5.201516736	5.16241042	3.45863601	3.1671805	3.9047007	4.0864558	4.0847757	3.4582072
ENSMUSG00000032572	Col6a4	-1.667604134	3.14E-06	5.52806525	5.17313917	5.1737707	4.99069578	5.664223877	5.27781519	2.99937492	3.5816684	3.9977603	3.8064143	4.5206589	4.2464084
ENSMUSG00000090558	Gm17202	-1.677950473	0.0053738	5.2138525	5.0475718	5.1737707	6.66220571	6.620815729	6.70611192	3.45863601	4.1660812	4.1676023	4.7537657	5.3891376	4.8563221
ENSMUSG00000076499	Trbv31	-1.68565388	0.0360205	4.17376203	3.5873738	3.46218583	3.31555453	2.995556056	3.31686005	2.99937492	2	2.5839675	2.8067906	2.5837918	2.8065305
ENSMUSG00000104452	Ighv8-8	-1.69099715	0.0473001	7.27159011	7.22268701	7.4960828	10.6484921	10.64843895	10.708383	7.68527438	7.7500353	7.5820378	8.4622223	8.4641303	8.4939519
ENSMUSG00000092060	Bend4	-1.695638104	0.0001197	5.13365172	4.46239037	4.86171081	4.38371152	4.240904489	4.38547538	3.32117796	3.1671805	3.9047007	3.1691935	2.9982436	3.4582072
ENSMUSG00000039323	Igfbp2	-1.696835028	0.0155545	4.39631085	4.52654927	4.32538969	6.29368298	6.014015574	6.4676579	4.52252907	4.6397044	4.2455699	2.9993416	3.9973646	4.0859914
ENSMUSG00000052613	Pcdh15	-1.70526148	0.0200929	3.70385559	3.9095428	3.17232976	3.57787902	4.163006272	4.24125532	3.32117796	2	2.5839675	2.8067906	2.5837918	3.3207737
ENSMUSG00000087289	4933424M12Rik	-1.708254864	0.0246957	5.00431594	5.2511628	5.28928485	7.54417771	7.467032452	7.33160274	4.52252907	4.3883165	4.0851792	5.4250703	5.7781007	5.6986634
ENSMUSG00000027983	Cyp2u1	-1.715962379	0.0335129	3.32488899	3.70294367	3.32452507	3.79976415	3.316593717	3.69459039	2.99937492	2.5833164	2	2.3216648	3.3198201	2.3215434
ENSMUSG00000038677	Scube3	-1.716221324	0.0047091	3.17266678	4.25078255	4.17329055	3.79976415	3.99332894	4.08100044	2.80681915	2.5833164	3.4575315	2.8067906	2.5837918	2.9990381
ENSMUSG00000040627	Aicda	-1.729654183	0.0426866	5.95881011	6.00338973	5.3258218	7.04496523	7.181167553	7.34930219	3.16923045	3.1671805	3.9977603	5.5837553	5.8547087	5.9050945
ENSMUSG00000045903	Npas4	-1.736633447	0.0001111	4.86223324	4.17273779	5.0912803	5.19996894	4.577548304	4.99260313	3.32117796	2.9975301	3.1682663	3.9990123	4.0847757	3.1688562
ENSMUSG00000024459	H2-M5	-1.777632598	0.0231094	4.25182216	4.0902284	4.32538969	5.544859	5.635668724	5.89899925	2.32167809	3.4562874	2.9985073	4.0864558	3.9043138	4.5219723
ENSMUSG00000022375	Lrrc6	-1.787705838	0.0366908	3.00246783	3.17193469	3.32452507	3.45267087	3.801002232	3.31686005	2.32167809	2.3209407	2	2.9993416	2.5837918	2.8065305
ENSMUSG00000033498	Strc	-1.792551912	0.023295	3.70385559	4.58797599	4.39582017	6.34743447	6.258348698	6.40133334	3.584129	3.5816684	3.3201366	4.4583541	4.1671919	4.9052229
ENSMUSG00000062991	Nrg1	-1.792764353	0.0170643	4.25182216	3.5873738	4.17329055	4.79824119	5.036574414	4.99260313	2.80681915	2	3.1682663	4.1689007	3.1679733	3.4582072
ENSMUSG00000118541	Nrg1	-1.792764353	0.0170643	4.25182216	3.5873738	4.17329055	4.79824119	5.036574414	4.99260313	2.80681915	2	3.1682663	4.1689007	3.1679733	3.4582072
ENSMUSG00000014030	Pax5	-1.793764085	0.0008075	7.5517206	7.85530195	7.64086349	6.84771084	6.606172633	6.82473091	4.39130525	4.5808437	4.4569882	6.2275719	6.2061286	6.207633
ENSMUSG00000009545	Kcnq1	-1.805537792	0.0021064	5.13365172	5.28864725	5.67641223	3.57787902	4.314811199	4.57791872	3.32117796	3.3189638	3.805222	2.9993416	3.4571958	3.9985569
ENSMUSG00000095642	Ighv14-3	-1.812535998	0.000603	6.74621438	7.17344013	7.08101331	9.04743355	9.013534878	9.03052682	6.33866134	6.2241389	6.5970492	6.7800906	6.4395903	6.9639214
ENSMUSG00000020866	Cacna1g	-1.814934396	0.0423451	8.48060956	8.53885188	8.32168415	5.19996894	5.036574414	5.74705896	6.32074021	6.0828102	6.6118449	4.8568457	5.2063188	5.2836752
ENSMUSG00000104554	Gm4610	-1.82313928	0.0389135	3.32488899	3.70294367	3.46218583	3.31555453	4.163006272	2.99577786	2	2.9975301	2.5839675	2.8067906	2	2.9990381
ENSMUSG00000112160	BC024063	-1.827104442	0.0131606	3.17266678	4.58797599	3.32452507	5.27585864	5.239965497	4.99260313	2.99937492	3.1671805	3.805222	2.8067906	3.3198201	3.5836798
ENSMUSG00000053541	Gvin-ps6	-1.828783184	0.0037353	4.58907321	4.32482117	4.75857317	5.41661938	5.799090957	5.27781519	2.80681915	3.1671805	2.5839675	4.1689007	4.1671919	4.1684284
ENSMUSG00000096326	Ighv1-78	-1.838954393	0.0105755	5.36200308	5.39558892	5.5585469	7.92617395	7.798612743	7.94004791	4.95310728	4.85372	4.6413475	5.8814153	5.6406227	5.8808491
ENSMUSG00000098132	Rassf10	-1.840538762	0.0270067	6.63408914	6.58842747	6.32603781	4.23953538	3.900368117	4.45251622	3.32117796	3.9032667	3.3201366	4.7537657	4.5206589	4.6422398
ENSMUSG00000096410	Ighv1-19	-1.849337737	0.0243267	6.61944034	6.19324212	6.7985859	9.82229854	9.932182321	9.91639074	6.95298623	7.2431139	7.2259114	7.1686446	7.1564548	7.4493306
ENSMUSG00000094797	Igkv6-15	-1.859862179	0.031072	7.61216077	7.42979621	7.50407612	11.1244486	11.01971225	11.2052694	8.09152504	8.219124	8.2591468	8.5339726	8.6075458	8.5255734
ENSMUSG00000071178	Serpina1b	-1.861758839	0.0041252	3.46257176	3.5873738	3.91006404	4.5761027	4.850310455	4.57791872	2.80681915	2.3209407	2.9985073	3.321138	3.4571958	2.9990381
ENSMUSG00000042515	Pwwp3b	-1.870665402	0.0146837	5.58948364	5.28864725	5.25179848	8.09804089	7.824145038	7.82458214	4.75382239	4.6397044	4.5824738	5.7536681	5.9509084	5.8808491
ENSMUSG00000093894	Ighv1-53	-1.874494637	0.040826	6.0707267	6.2128736	6.09153444	9.8442762	9.923349689	10.0359696	7.23718744	7.1347479	7.2638772	7.2081719	7.0626793	7.2269456
ENSMUSG00000061947	Serpina10	-1.877594268	0.0459748	3.46257176	2.8089055	2.58640584	4.69144319	4.577548304	4.31516673	2.58454581	2.3209407	3.1682663	2.9993416	2.9982436	2.8065305
ENSMUSG00000052336	Cx3cr1	-1.901181134	1.73E-07	6.3797336	6.30721334	6.46356097	7.2184651	7.248719646	7.34047961	4.99890593	4.1660812	4.6413475	5.4250703	5.2822481	5.6986634
ENSMUSG00000051747	Ttn	-1.91998891	2.96E-06	4.91116549	5.42954425	5.88667588	6.34743447	6.649663449	6.45136042	4.16895254	3.9962936	3.9977603	4.64275	4.4565564	4.7532483
ENSMUSG00000074934	Grem1	-1.950079698	0.0126625	3.70385559	3.17193469	3.81044603	4.5761027	4.747308112	4.69328731	2.58454581	3.8038253	2.3213312	3.1691935	2.5837918	2.8065305
ENSMUSG00000021702	Thbs4	-1.960337509	0.0034411	4.81158291	4.81045442	4.81106345	5.92079904	5.692224792	5.82502842	2.99937492	2	3.9977603	4.3208746	4.1671919	4.0859914
ENSMUSG00000061603	Akap6	-1.965947253	0.016662	4.64799974	4.91002449	3.91006404	7.33835186	7.120636493	7.17168638	4.45840862	3.9962936	3.9977603	4.8568457	5.2063188	4.9052229
ENSMUSG00000044522	A730020M07Rik	-1.966367703	0.0038385	4.00370016	4.46239037	3.46218583	5.84807889	5.898584129	5.60694538	3.584129	3.1671805	3.9047007	3.6995281	3.3198201	3.8059806
ENSMUSG00000041216	Clvs1	-1.994398357	0.0313241	5.00431594	4.75796789	4.52713629	7.75774193	7.583740466	7.44294829	4.08650672	3.9962936	3.805222	5.7267029	4.8043426	5.8311007
ENSMUSG00000028003	Lrat	-1.999187979	0.0015526	3.17266678	4.00271242	3.81044603	4.07933474	4.080660667	4.24125532	2.80681915	2.5833164	2.3213312	2.5845236	2.8058495	3.3207737
ENSMUSG00000036928	Stag3	-2.01141966	0.0241236	6.23348755	5.78471251	6.54329872	3.57787902	3.579034195	3.80131951	4.39130525	4.1660812	3.5829719	3.321138	3.3198201	3.5836798

ENSMUSG00000073821	8030451A03Rik EN	-2.034526497	0.0015178	4.17376203	4.32482117	4.00324548	5.77149776	5.664223877	5.82502842	2.80681915	3.5816684	3.3201366	4.1689007	3.6980072	3.4582072
ENSMUSG00000031289	Il13ra2	-2.058257339	0.0065722	5.64839374	5.39558892	5.00378569	7.75774193	7.568714194	7.58417614	4.69938173	4.2440258	3.4575315	5.4906532	5.2822481	5.6986634
ENSMUSG00000025905	Oprk1	-2.074340283	0.036233	5.09181499	4.81045442	4.70410076	8.52863532	8.502948884	8.52301648	6.20827055	6.40468	5.6119669	4.8568457	5.3891376	4.4578572
ENSMUSG00000094689	Ighv1-81	-2.078084829	0.0143003	6.8874076	6.49530804	7.11272495	10.3934704	10.34757759	10.3380831	6.84428313	7.0826646	7.0951324	7.7866094	7.7312607	7.7395785
ENSMUSG00000034731	Dgkh	-2.078894396	0.0020105	6.82493613	6.77166724	6.77235151	9.55166062	9.576107386	9.44280291	6.47453922	6.3703341	6.4065447	6.67116	6.9154646	7.1376815
ENSMUSG00000048001	Hes5	-2.088807711	0.0428446	4.91116549	4.95734574	5.04819618	9.20860188	9.306304012	9.32475128	6.71304274	6.3703341	6.5970492	6.2082076	5.9509084	5.8808491
ENSMUSG00000039691	Tspan10	-2.100528015	0.0003964	5.09181499	5.13248572	4.91064028	6.31182357	6.276958431	6.40133334	2.99937492	3.3189638	3.3201366	4.6993254	4.5206589	4.3907597
ENSMUSG00000087670	9530036M11Rik	-2.114066048	0.0201062	3.32488899	2.58616865	3.17232976	3.79976415	3.579034195	3.57933023	2.58454581	2.3209407	2	2.8067906	2.3212258	2.5843213
ENSMUSG00000076680	Ighv6-6	-2.114257759	0.0200546	5.46391545	5.67575754	5.86200878	9.3795943	9.355287233	9.42830383	6.10734654	5.9022768	5.9279464	6.8690927	6.7108646	6.7396145
ENSMUSG00000067242	Lgi1	-2.200640717	0.0064262	4.52763697	4.3952449	4.325389669	7.14953168	7.295105165	7.20122591	5.08635957	4.5194791	4.6413475	3.9990123	3.9973646	3.9985569
ENSMUSG00000114203	Gm35279	-2.217445901	1.85E-05	4.00370016	4.52654927	4.39582017	4.89767527	4.577548304	4.08100044	3.45863601	3.3189638	3.2213312	2.8067906	2.5837918	2.9990381
ENSMUSG00000048905	Bnip5	-2.229472198	0.0404492	7.95321895	8.05340948	7.89907086	9.44493511	4.899179037	4.69328731	3.45863601	3.4562874	3.1682663	5.8814153	5.7781007	5.7261413
ENSMUSG00000040536	Necab1	-2.231610422	0.0404492	7.36236337	7.23233783	7.37926104	11.6241862	11.6426097	11.5374844	8.18859126	8.3349672	8.1468022	8.6533321	8.7176176	8.5905525
ENSMUSG00000058246	Gm10037	-2.270456851	0.0003526	4.52763697	4.0902284	3.81044603	4.23953538	3.694282913	4.31516673	2.80681915	2.5833164	3.4575315	2.3216648	2.9982436	2
ENSMUSG00000091679	Vmn2r96	-2.275034215	0.000118	4.39631085	4.32482117	3.46218583	4.38371152	4.314811199	4.51657958	2.99937492	2	3.4575315	2.8067906	2.5837918	2.8065305
ENSMUSG00000015599	Ttbk1	-2.282827469	0.0480931	3.17266678	3.00180885	2.32279427	3.31555453	3.99332894	3.90069389	2.80681915	2.3209407	2.3213312	2.8067906	2	2
ENSMUSG00000096638	Ighv2-9	-2.313943793	0.0120474	4.46346769	3.8099383	4.395820117	7.49739099	7.642327755	7.58417614	3.80646187	3.9962936	4.5824738	4.9988477	5.0413056	4.7532483
ENSMUSG00000103749	Pcdhgb5	-2.32085305	0.0062016	3.32488899	3.17193469	4.00324548	4.07933474	3.99332894	3.99366215	2.32167809	2.3209407	3.4575315	2.5845236	2	2.3215434
ENSMUSG00000034634	Ly6d	-2.323074219	0.0074472	10.1910288	10.1016343	10.0930981	13.29557	13.24981526	13.4378543	10.810127	10.892912	10.810801	8.9175571	8.6295157	8.9406057
ENSMUSG00000108187	4930511E03Rik	-2.326454041	0.0294049	4.64799974	5.64718272	4.81106345	3.31555453	2.320152159	3.45405584	2.58454581	2.3209407	2.5839675	2.8067906	3.4571958	3.3207737
ENSMUSG00000086638	4930405A21Rik	-2.349510243	0.0029462	3.17266678	3.8099383	3.17232976	4.16165755	3.45377331	3.80131951	2.58454581	2	2.5839675	2.3216648	2.5837918	2.8065305
ENSMUSG00000077431	Gm22591	-2.349610144	0.0018982	4.00370016	3.8099383	4.32538969	3.31555453	3.316593717	3.31686005	2.80681915	2.3209407	2.5839675	2.3216648	2.8058495	2.3215434
ENSMUSG00000031297	Slc7a3	-2.353648776	0.0010718	4.00370016	4.3952449	4.52713629	6.55966682	6.606172633	6.54649305	3.45863601	3.4562874	3.4575315	3.9990123	4.4565564	3.9985569
ENSMUSG00000096461	Igkv14-130	-2.354895026	0.0111291	4.70461358	4.70349952	4.17329055	7.80972963	7.939610206	7.87433013	4.69938173	4.3883165	3.4575315	5.1687544	5.0843618	5.4245194
ENSMUSG00000094686	Ccl21a	-2.373678825	7.02E-11	6.97055819	6.74494743	6.77235151	8.15943499	8.068046255	8.16158613	5.32080275	5.7503104	5.520835	5.2467492	4.8549513	5.3558154
ENSMUSG00000040907	Atp1a3	-2.385835463	0.0005949	6.13393312	5.61803048	6.37915695	8.9638612	8.921908906	9.02778156	5.69928551	6.0614409	5.8045815	5.8567548	5.8793666	5.7795753
ENSMUSG00000049100	Pcdh10	-2.392215398	0.0024843	3.8108791	3.5873738	4.09077189	3.79976415	4.452152566	2.99577786	2.32167809	2.3209407	2	2.9993416	2.5837918	2.9990381
ENSMUSG00000112797	Gm30034	-2.413884508	0.0260061	2.80947046	2.58616865	3.17232976	5.19996894	5.546446959	5.34992256	2.58454581	3.3189638	2.3213312	3.1691935	2.8058495	3.3207737
ENSMUSG00000012350	Ehf	-2.423718249	0.0057917	4.17376203	4.46239037	4.70410076	7.07713855	7.375016529	7.17168638	3.16923045	3.1671805	3.9977603	4.3912513	4.9511354	4.8563221
ENSMUSG00000095889	Ighv1-58	-2.435715517	0.0184221	4.58907321	4.32482117	3.58784774	7.82875198	7.939610206	8.00290208	3.584129	4.3883165	3.9047007	5.4906532	5.1261702	5.2077371
ENSMUSG00000076577	Igkv8-30	-2.4403939	0.0002292	8.43532692	8.54660853	8.50412385	11.4676407	11.44077569	11.4504746	8.05405081	8.4748918	8.3677366	8.1124442	8.1206568	8.0315279
ENSMUSG00000094787	Ighv1-54	-2.454515356	0.0162564	4.86223324	5.003164	4.09077189	8.50517823	8.594816539	8.60265489	4.6428059	3.9962936	4.804795	6.0862233	5.9739884	5.3905763
ENSMUSG00000043531	Sorcs1	-2.457804767	0.0042414	2.58660819	3.00180885	3.91006404	3.79976415	4.240904489	4.08100044	2.32167809	2.5833164	2.5839675	2.5845236	2.5837918	2.3215434
ENSMUSG00000094491	Igkv1-133	-2.496119535	0.0148386	4.70461358	4.52654927	4.17329055	7.94373022	8.041081703	8.07381756	3.80646187	3.4562874	3.9047007	5.0863008	5.7781007	5.3558154
ENSMUSG00000096670	Ighv2-6	-2.517592735	0.0307395	3.00246783	2.58616865	2.58640584	6.32973889	6.383840938	6.515474	3.45863601	3.5816684	3.5829719	3.1691935	3.4571958	3.6991077
ENSMUSG00000094051	Ighv1-36	-2.525454004	0.0049439	4.46346769	4.25078255	4.00324548	7.82875198	7.904135911	7.69214615	4.80628319	4.8031183	4.6413475	4.6993254	4.3894726	4.2464084
ENSMUSG00000030268	Bcat1	-2.545253757	3.80E-08	8.60479354	8.4589015	8.5892432	9.497215	9.520577265	9.52880739	5.58381631	5.9022768	5.1266377	7.1983912	7.0518733	7.3818259
ENSMUSG00000095981	Ighv10-1	-2.561629689	0.0048259	4.95849239	5.13248572	5.04819618	8.44481059	8.462874201	8.51911228	4.45840862	4.1660812	4.2455699	5.699224	5.520353	5.9289391
ENSMUSG00000076550	Igkv4-63	-2.562292137	0.010586	4.09123546	4.3952449	4.58856814	8.27951699	8.041081703	8.58408826	5.08635957	5.8533786	5.1672702	4.5224741	4.5820339	4.1684284
ENSMUSG00000095700	Ighv10-3	-2.565463433	0.0100645	4.75908943	5.46271875	5.5585469	9.30684125	9.3310035	9.36880488	5.28428008	5.0831014	4.804795	6.5685941	6.5044343	6.3380206
ENSMUSG00000094561	Ighv1-22	-2.566272178	0.0115536	4.75908943	4.81045442	5.25179848	9.6278512	9.444419964	9.51318993	5.80619384	6.0397503	6.206628	6.1072838	6.0627843	6.3019538
ENSMUSG00000097276	4930525G20Rik	-2.583426162	0.0481825	3.00246783	2.8089055	3.00216447	3.57787902	3.900368117	3.31686005	2	2.3209407	2	2	3.1679733	2
ENSMUSG00000069515	Lyz1	-2.586054955	7.62E-07	5.58948364	5.67575754	5.1737707	6.78416229	6.620815729	6.34950901	3.16923045	3.3189638	2.9985073	4.2468879	4.6409042	4.3203887
ENSMUSG00000044453	Ffar1	-2.612777249	0.0093738	3.70385559	4.52654927	3.17232976	3.57787902	3.316593717	3.57933023	2.32167809	2.3209407	2	2.3216648	3.3198201	2
ENSMUSG00000096672	Ighv1-63	-2.615708106	0.0258084	4.25182216	4.32482117	3.58784774	7.22804926	7.161271392	7.29553879	2.32167809	2.9975301	2.5839675	4.5838651	4.5820339	5.1275786
ENSMUSG00000022899	Slc15a2	-2.650478955	1.05E-09	7.81219846	7.86773959	7.86223222	9.52274907	9.478988158	9.5461773	6.68529867	6.5802249	6.7113724	5.699224	6.0190694	5.9050945
ENSMUSG00000043230	Fam124b	-2.668332141	0.0335007	3.00246783	2	3.00216447	4.23953538	3.801002232	4.45251622	2.32167809	2.3209407	2	2.8067906	2.3212258	2.5843213
ENSMUSG00000026616	Cr2	-2.69202042	0.0144066	5.55910126	5.42954425	5.91092831	2.99469065	2.995556056	2.58214912	2.99937492	3.4562874	2.5839675	2.3216648	3.1679733	2.9990381
ENSMUSG00000034486	Gbx2	-2.727323324	0.0044927	3.70385559	3.17193469	3.81044603	3.99202864	2.995556056	4.08100044	2	2	2	2.8067906	2.3212258	2.9990381
ENSMUSG00000094345	Igkv14-126	-2.733466338	0.001965	5.2138525	5.2511628	5.133115	9.09534772	9.15355204	9.20348884	5.64270583	5.5804312	5.752122	5.5837553	5.4562365	5.6420858
ENSMUSG00000035429	Ptprh	-2.772185218	0.0027258	3.17266678	3.32409844	3.46218583	3.79976415	3.316593717	3.45405584	2.32167809	2.3209407	2	2	2.3212258	2.8065305
ENSMUSG00000038086	Hspb2	-2.805994146	0.0105016	6.0707267	5.88601365	6.09153444	2.58142511	3.801002232	2.32024072	2.80681915	3.1671805	2.9985073	3.1691935	3.4571958	2.9990381
ENSMUSG00000096498	Ighv2-5	-2.81457046	0.01312	3.70385559	4.0902284	3.32452507	8.05021758	8.013603558	8.27705428	3.32117796	3.8038253	4.2455699	5.3911259	4.9969249	4.8057055
ENSMUSG00000074892	B3galt5	-2.822115619	0.0081977	3.32488899	3.17193469	3.17232976	7.23757017	7.024794002	7.03619444	3.69957415	4.2440258	3.3201366	3.9990123	3.3198201	3.9054796
ENSMUSG00000044550	Tceal3	-2.840159028	3.70E-05	8.2336845	8.4589015	8.10229472	6.38218749	6.349085887	6.36699145	4.90580695	3.4562874	3.1682663	5.7267029	5.520353	5.1682145
ENSMUSG00000094016	Trav15-1-dv6-1	-2.917505204	0.0026227	6.67716372	6.61817789	6.44707059	3.99202864	3.45377331	3.45405584	2.58454581	3.4562874	2.5839675	3.321138	4.0847757	3.8059806
ENSMUSG00000076552	Igkv4-61	-2.926722227	0.0002743	5.86257288	5.36081511	5.58892821	8.68990408	8.348759273	8.84023986	4.58392055	4.4553878	3.5829719	5.4906532	5.724671	5.3905763
ENSMUSG00000042359	Osbpl6	-3.003204091	0.0053577	3.17266678	2.58616865	4.09077189	6.70401392	6.811593384	6.69230923	3.69957415	3.3189638	3.9977603	2.8067906	3.6980072	2.5843213
ENSMUSG00000091345	Col6a5	-3.03071332	0.0099664	4.52763697	4.17273779	4.52713629	6.51338782	6.499285457	6.70611192	2.32167809	2	2	4.3208746	3.8048451	4.0859914
ENSMUSG00000038576	Susd4	-3.052445339	9.33E-07	10.8597892	10.929904	10.923925	8.62246447	8.530353201	8.61001516	6.26560109	6.0397503	6.1870014	7.8813484	7.7844513	7.5059125
ENSMUSG00000000794	Kcnn3	-3.127733986	0.0037076	8.07094716	7.99791223	8.10755067	4.94493511	5.036574414	5.03696515	2.80681915	2.5833164	2.5839675	5.2842203	4.5820339	5.3905763
ENSMUSG00000102301	Ighv8-2	-3.247346425	0.0280326	2.80947046	2	2	5.69062254	5.418193514	5.24036336	2.58454581	2.3209407	2.5839675	2.8067906	2.8058495	2.5843213
ENSMUSG00000076646	Ighv2-6-8	-3.251627789	0.0132579	2.80947046	3.17193469	2.58640584	4.69144319	4.747308112	5.12179534	2	2.5833164	2	3.1691935	2.5837918	2
ENSMUSG00000076547	Igkv4-70	-3.253045915	0.0101608	3.46257176	4.00271242	5.1737707	9.67941138	9.319828853	9.48944209	5.28428008	5.7767759	5.9041029	4.9988477	4.9511354	5.3201962
ENSMUSG00000076839	Trav13-1	-3.266104333	7.43E-08	4.52763697	5.13248572	4.09077189	6.01238644	5.922421116	5.99207333	2.99937492	3.1671805	2.3213312	2.9993416	2.8058495	3.5836798
ENSMUSG00000006154	Eps8l1	-3.278531001	1.93E-05	8.71224347	8.74504867	8.76583712	5.1198645	5.546446959	5.45174579	4.45840862	4.8031183	4.7523434	5.0863008	5.1261702	4.3907597
ENSMUSG00000030785	Cox6a2	-3.288989191	0.043464	2	2.58616865	2	5.19996894	5.515436574	5.12179534	2.58454581	2	2.5839675	2.5845236	2.8058495	2.5843213
ENSMUSG00000094164	Ighv2-3	-3.322598253	4.70E-34	6.71898941	6.67589916	6.58910821	7.30251325	7.151219462	7.40113382	4.16895254	3.4562874	3.9977603	4.0864558	4.3191168	4.0859914
ENSMUSG00000110386	Gm42031	-3.463473558	6.02E-21	7.81862512	7.7717335	7.75913321	7.52097401	7.663698793	7.37545076	4.08650672	3.4562874	3.1682663	5.2467492	4.6974661	4.9525203
ENSMUSG00000025330	Padi4	-3.534842273	1.12E-10	6.39701442	6.55805062	6.60406041	8.58566181	8.670665591	8.77298015	4.8569031	4.3883165	4.3898999	4.1689007	4.4565564	5.3558154
ENSMUSG00000076571	Igkv5-37	-3.542149346	0.0384967	2.32291573	2	2	5.41661938	5.576804784	5.20191333	2.32167809	2.5833164	2	2.5845236	2.8058495	2.5843213
ENSMUSG00000106387	Igkv4-73	-3.579990742	0.0452697	2.58660819	2.32265191	2	4.31342374	3.16498644	3.99366215	2	2.3209407	2.3213312	2.3216648	2	2
ENSMUSG00000076549	Igkv4-68	-3.6129163	0.0015478	6.6485907	6.64732718	6.7985859	11.9720094	11.89084227	12.0800081	7.4986231	7.3702148	7.1967667	7.4416568	7.6331804	7.4493306
ENSMUSG00000095711	Trav14-2	-3.710279243	0.0003322	3.46257176	3.00180885	3.32452507	6.46557494	6.313472863	6.66430124	3.16923045	2.3209407	2.3213312	2.9993416	3.3198201	2.9990381
ENSMUSG00000021313	Ryr2	-3.720813384	2.16E-07	8.26696215	8.46300602	8.47595224	6.49762561	6.705684016	6.6783732	3.16923045	2.5833164	3.1682663	4.9057492	4.7518938	5.3558154
ENSMUSG00000098161	Platr11	-3.749249395	0.0380006	2.58660819	2	2	4.38371152	4.080660667	4.69328731	2	2.3209407	2.3213312	2.3216648	2	2.3215434
ENSMUSG00000076484	Trbj1-2	-3.800643321	0.0172876	6.43096721	5.83625203	6.39643742	2.80280525	2.803546666	2.32024072	2	2	2	3.1691935	3.3198201	3.1688562
ENSMUSG00000085041	BB031773	-3.833191968	0.0059883	2.80947046	3.5873738	2.58640584	5.544859	5.546446959	5.57721245	2	2.5833164	3.4575315	2	2.3212258	2
ENSMUSG00000034009	Rxfp1	-3.867939335	5.75E-14	7.48055424	7.60345382	7.71160216	5.71808778	5.922421116	5.82502842	3.45863601	3.9032667	3.805222	3.1691935	3.4571958	3.8059806
ENSMUSG00000086503	Xist	-3.874310419	7.54E-06	16.5184892	16.4205777	16.4904377	12.6978054	12.72687116	12.6852532	11.1299657	11.156826	11.140402	12.067798	12.144329	12.118315
ENSMUSG00000095338	Igkv3-9	-3.89424805	1.98E-07	6.46413927	6.3957609	6.49598681	5.69062254	5.746647149	5.82502842	2.32167809	2	2	2.8067906	3.9043138	3.9985569
ENSMUSG00000030257	Srgap3	-3.910469444	0.0005291	5.28982865	4.81045442	5.3962317	10.2805665	10.26608768	10.3741928	6.0432195	5.3878451	5.5822247	5.5223595	5.5817408	5.042703
ENSMUSG00000096577	Ighv1-71	-3.936043964	0.0291132	2	2	2.58640584	5.44976368	5.692224792	5.20191333	2	2.3209407	2	2.8067906	2.5837918	2.5843213
ENSMUSG00000029651	Mtus2	-3.937942553	1.02E-05	6.17458292	6.1326921	5.95824332	8.30690819	8.29041978	8.45924472	4.75382239	4.9498913	4.5210949	2	2.8058495	2.9990381
ENSMUSG00000076480	Trbv29	-3.980654562	0.0002212	3.00246783	3.4617334	3.58784774	7.16956531	7.576246893	7.47554863	2.58454581	3.3189638	2.9985073	2.8067906	4.0847757	3.1688562
ENSMUSG00000013418	B4galnt2	-4.080490993	0.0277326	2	2.32265191	2	5.07808018	5.239965497	5.34992256	2.58454581	2	2.3213312	2.5845236	2	2.3215434
ENSMUSG00000027849	Syt6	-4.138467199	0.0280906	2.32291573	2.32265191	2	3.79976415	4.452152566	3.57933023	2	2.3209407	2	2	2	2.3215434
ENSMUSG00000095866	Ighv2-4	-4.154376117	4.62E-05	3.32488899	3.8099383	3.32452507	4.99069578	5.349521258	5.38466829	2.99937492	2.3209407	2	2	2.3212258	2.3215434
ENSMUSG00000044678	Ly6k	-4.18160157	1.76E-06	7.07087367	7.24192452	7.0265606	4.31342374	4.38511559	4.31516673	3.45863601	3.1671805	3.4575315	2.8067906	2	2.8065305
ENSMUSG00000026322	Htr4	-4.187846233	0.0044827	3.00246783	3.4617334	3.46218583	8.41993804	8.446527354	8.48349066	2.58454581	2.5833164	2.3213312	4.5224741	4.4565564	4.3203887
ENSMUSG00000106620	Trav7-5	-4.354587263	0.0001195	3.32488899	3.17193469	3.32452507	3.79976415	3.694282913	3.57933023	2	2	2	2.3216648	2	2.3215434
ENSMUSG00000076485	Trbj1-3	-4.448917925	1.79E-08	7.16466507	6.98078072	6.98146849	6.38218749	6.201034321	5.89899925	2	2	2	3.9059249	3.3198201	3.8059806
ENSMUSG00000100277	1810053B23Rik	-4.528205816	0.000223	5.13365172	4.75796789	4.81106345	2.80280525	3.16498644	3.31686005	2	2	2.3213312	2	2.5837918	2.3215434
ENSMUSG00000076846	Trav13-2	-4.550098383	0.001944	2.58660819	3.00180885	2.58640584	4.89767527	4.992214091	5.16241042	2	2.5833164	2	2	2.5837918	2
ENSMUSG00000018451	6330403K07Rik	-4.763356575	0.0321698	2	2.32265191	2.32279427	5.31235716	5.451341511	5.12179534	2	2.9975301	2	2	2	2
ENSMUSG00000072601	Ear1	-4.956717609	0.0017395	2.80947046	2.32265191	2.32279427	4.7458302	4.516212395	4.57791872	2.32167809	2	2.3213312	2	2	2
ENSMUSG00000076483	Trbj1-1	-5.231797932	0.0001963	7.19462112	7.24192452	7.2330292	2.80280525	3.579034195	2.8037367	2	2	2	2.8067906	2.9982436	3.1688562
ENSMUSG00000102524	Ighv1-2	-5.263155979	0.0002889	3.70385559	3.17193469	3.46218583	10.3469463	10.33431159	10.3101127	3.80646187	3.5816684	2.9985073	4.9988477	5.2063188	4.4578572
ENSMUSG00000076473	Trbv16	-5.382278919	2.02E-11	9.60853248	9.60536763	9.5608088	7.03407934	6.910256766	6.92255873	2.32167809	4.0836837	5.2067896	2.8067906	3.6980072	3.1688562
ENSMUSG00000114348	Gm41031	-5.471990443	3.84E-07	3.46257176	3.5873738	3.32452507	3.6930831	3.45377331	3.99366215	2	2	2	2	2	2
ENSMUSG00000030996	Art1	-5.644584746	4.07E-08	4.17376203	4.25078255	4.39582017	3.79976415	3.99332894	3.69459039	2	2	2	2.3216648	2	2
ENSMUSG00000093966	Trav4-3	-5.783417276	0.0012717	2	3.00180885	2.58640584	4.38371152	4.314811199	4.69328731	2	2	2	2	2	2
ENSMUSG00000096656	Trav12-2	-5.843904197	0.0014073	2.58660819	2	2.32279427	5.51385184	5.48374496	5.38466829	2.32167809	2	2	2	2	2.3215434
ENSMUSG00000095958	Trav12-3	-5.916142207	0.0054503	2	2.58616865	2	5.99002889	6.16151936	5.79950395	2	2	2	2.5845236	2.3212258	2
ENSMUSG00000057163	Prss2	-6.418945482	0.0002294	11.3064198	11.3721164	11.3177688	7.09819562	6.849387244	7.20122591	5.24680876	5.3174793	4.8554064	2	2	2
ENSMUSG00000120741	Gm33302	-7.019412621	4.18E-06	6.15440119	6.1326921	5.86200878	3.57787902	2.582001393	2.58214912	2.32167809	2	2	2	2	2
ENSMUSG00000076462	Trbv2	-7.051421853	8.22E-32	8.67730852	8.83647377	8.73560407	11.2828504	11.17536922	11.1463763	2.58454581	4.1660812	3.9047007	3.5840846	3.9043138	4.3907597
ENSMUSG00000076463	Trbv3	-7.247456903	6.74E-13	11.4977792	11.5941978	11.5425088	6.52897969	6.861768337	6.6783732	3.16923045	3.4562874	3.4575315	4.4583541	3.6980072	4.2464084
ENSMUSG00000094262	Igkv4-62	-8.560340112	4.58E-09	3.588252	3.32409844	3.91006404	8.08227528	8.041081703	8.03606595	2.32167809	2	2	2.3216648	2	2
ENSMUSG00000076475	Trbv19	-10.33295226	5.53E-77	10.8243013	10.8325373	10.7815712	12.7705225	12.74473817	12.6710286	2.58454581	3.1671805	3.1682663	2.5845236	2.8058495	2.8065305
ENSMUSG00000076474	Trbv17	-11.44185643	1.61E-23	12.5814126	12.562512	12.6502066	8.19895935	8.181045251	8.08969923	2.58454581	2.3209407	2	2.3216648	2.5837918	2.3215434

Table S3_Hallmark pathways enriched in Bcat1 WT and KO leukemias

Pathways enriched in Bcat1 WT leukemias	ES	NES	NOM p-val	FDR q-val
HALLMARK_G2M_CHECKPOINT	0.42567	1.71925	0	0.006739
HALLMARK_MITOTIC_SPINDLE	0.41392	1.68235	0	0.006137
HALLMARK_EPITHELIAL_MESENCHYMAL_TRANSITION	0.34885	1.423	0.004451	0.097323
HALLMARK_E2F_TARGETS	0.34738	1.40488	0.0118871	0.087318
HALLMARK_IL2_STAT5_SIGNALING	0.29979	1.21522	0.0751105	0.416291
HALLMARK_UV_RESPONSE_DN	0.31143	1.21287	0.1036496	0.353612
HALLMARK_COAGULATION	0.28995	1.13833	0.1869301	0.530567
HALLMARK_ESTROGEN_RESPONSE_EARLY	0.27199	1.10751	0.2315341	0.573327
HALLMARK_INFLAMMATORY_RESPONSE	0.2671	1.07843	0.2759104	0.6134
HALLMARK_HEDGEHOG_SIGNALING	0.34868	1.06397	0.3468697	0.604395
HALLMARK_TGF_BETA_SIGNALING	0.31186	1.04334	0.3811802	0.620579
HALLMARK_MYOGENESIS	0.25379	1.03423	0.3644444	0.600102
HALLMARK_TNFA_SIGNALING_VIA_NFKB	0.23717	0.97192	0.5369318	0.76375
HALLMARK_SPERMATOGENESIS	0.25016	0.96383	0.5342262	0.735256
HALLMARK_KRAS_SIGNALING_DN	0.23191	0.94643	0.6017442	0.739215
HALLMARK_ESTROGEN_RESPONSE_LATE	0.2323	0.94442	0.6143057	0.69889
HALLMARK_UNFOLDED_PROTEIN_RESPONSE	0.24033	0.91822	0.6308943	0.73008
HALLMARK_ANGIOGENESIS	0.26646	0.83742	0.744186	0.88554
HALLMARK_WNT_BETA_CATENIN_SIGNALING	0.21143	0.66439	0.9622642	0.992732

Pathways enriched in Bcat1 KO leukemias	ES	NES	NOM p-val	FDR q-val
HALLMARK_OXIDATIVE_PHOSPHORYLATION	-0.55955	-2.41774	0	0
HALLMARK_ADIPOGENESIS	-0.44633	-1.96541	0	0
HALLMARK_PEROXISOME	-0.42111	-1.68117	0.0026667	0.016598
HALLMARK_DNA_REPAIR	-0.39622	-1.6771	0	0.01317
HALLMARK_REACTIVE_OXYGEN_SPECIES_PATHWAY	-0.48062	-1.62967	0.0025063	0.014993
HALLMARK_XENOBIOTIC_METABOLISM	-0.36976	-1.60909	0	0.014463
HALLMARK_INTERFERON_ALPHA_RESPONSE	-0.40215	-1.58082	0.005102	0.016218
HALLMARK_APOPTOSIS	-0.35749	-1.53048	0	0.023055
HALLMARK_P53_PATHWAY	-0.34366	-1.52925	0.0030211	0.020832
HALLMARK_BILE_ACID_METABOLISM	-0.37796	-1.51214	0.0058651	0.021403
HALLMARK_IL6_JAK_STAT3_SIGNALING	-0.39037	-1.4898	0.0086207	0.023926
HALLMARK_FATTY_ACID_METABOLISM	-0.34599	-1.47731	0.0031847	0.02465
HALLMARK_HYPOXIA	-0.3309	-1.44721	0.006079	0.029479
HALLMARK_INTERFERON_GAMMA_RESPONSE	-0.3166	-1.39444	0.012945	0.045257
HALLMARK_PI3K_AKT_MTOR_SIGNALING	-0.3471	-1.38569	0.0258621	0.046325
HALLMARK_COMPLEMENT	-0.31305	-1.35672	0.0186916	0.056331
HALLMARK_ALLOGRAFT_REJECTION	-0.29664	-1.30317	0.020339	0.081336
HALLMARK_PANCREAS_BETA_CELLS	-0.37285	-1.26095	0.1234867	0.110291
HALLMARK_KRAS_SIGNALING_UP	-0.27289	-1.20407	0.070946	0.166313
HALLMARK_MTORC1_SIGNALING	-0.27663	-1.20235	0.0758621	0.160013
HALLMARK_APICAL_JUNCTION	-0.26799	-1.18999	0.0664452	0.170627
HALLMARK_GLYCOLYSIS	-0.26816	-1.18638	0.0827815	0.167523
HALLMARK_MYC_TARGETS_V1	-0.25788	-1.13489	0.1456954	0.234451
HALLMARK_HEME_METABOLISM	-0.25118	-1.09828	0.2024169	0.292568
HALLMARK_UV_RESPONSE_UP	-0.25492	-1.08273	0.2739274	0.316627
HALLMARK_PROTEIN_SECRETION	-0.26803	-1.05734	0.3164894	0.359791
HALLMARK_NOTCH_SIGNALING	-0.31323	-0.98176	0.4774347	0.565478
HALLMARK_CHOLESTEROL_HOMEOSTASIS	-0.249	-0.94304	0.5605263	0.671222
HALLMARK_ANDROGEN_RESPONSE	-0.22428	-0.88852	0.7147059	0.817348
HALLMARK_APICAL_SURFACE	-0.23808	-0.81848	0.8004751	0.938566
HALLMARK_MYC_TARGETS_V2	-0.16052	-0.5775	0.9976247	0.999054

Table S4: Primer sequences for amplification of BCAT1 promoter using Methylation Specific PCR (MSP)

TARGET LOCI	DIRECTION	SEQUENCE (5' to 3')
BCAT1-prom-T1-M	FORWARD	GAGAGATTTTATTATTTGGGGGC
BCAT1-prom-T1-M	REVERSE	CTAACCGTATAAACCGAATCTACGA
BCAT1-prom-T1-U	FORWARD	GAGAGATTTTATTATTTGGGGGTG
BCAT1-prom-T1-U	REVERSE	TAACCATATAAACCAAATCTACAAC
BCAT1-prom-T1-WT*	FORWARD	GTGTCTTCCTGCTGATGCAA
BCAT1-prom-T1-WT	REVERSE	AGATCCCAAGGGTCGTAGC
ACTB	FORWARD	GTGATGGAGGAGGTTTAGTAAGTT
ACTB	REVERSE	AATTACAAAAACCACAACCTAATAAA

*WT, represents unmodified or wild-type primers. M, methylation-specific primers; and U, unmethylated-specific primers.

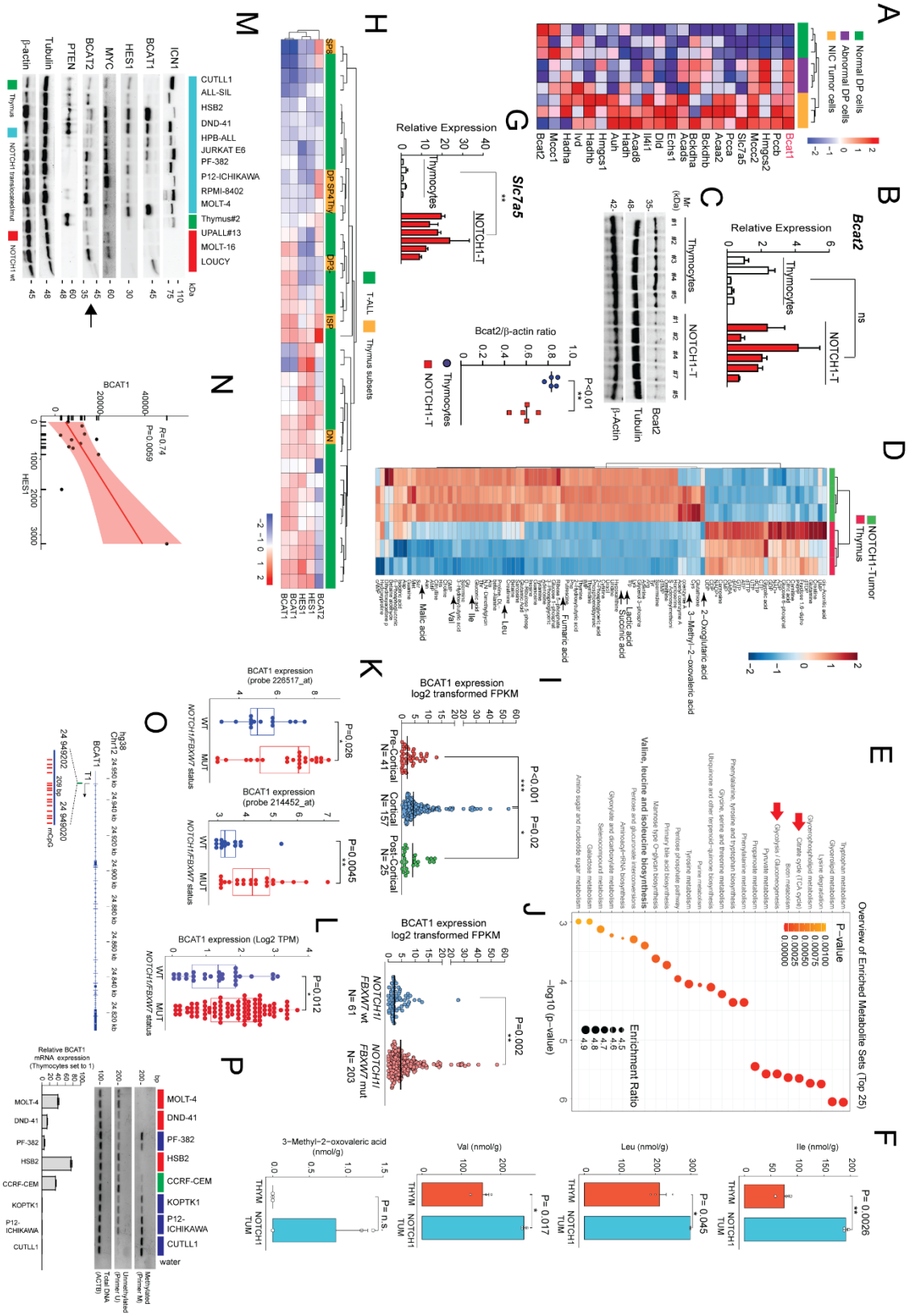


Figure S1. BCAT1 is highly expressed in NOTCH1 mutant T-cell acute lymphoblastic leukemia (T-ALL). (A) Heat map showing the expression levels of BCAA metabolic genes (N=22) between normal, abnormal (pre-

leukemic) DP cells and *ICN1*-induced DP leukemic cells (NIC Tumors). (B) Expression levels (qRT-PCR) of *Bcat2* in thymocytes obtained from 6-8 weeks old C57/Bl6 mice and leukemic cells from six *ΔE-NOTCH1* T-ALL tumors (NOTCH1-T). Significance was calculated using an unpaired two-tailed t-test. ns= not significant. (C) Western blot (top) showing protein expression levels of Bcat2. β-actin and tubulin are shown as loading controls. Graphical representation of Bcat2/β-actin ratios (bottom). Bars represent mean values. Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01. (D) Heatmap representation of metabolites identified by capillary electrophoresis time-of-flight mass spectrometry (CE-TOFMS) of thymic tissue (N=3) obtained from 6 weeks old C57/Bl6 mice and NOTCH1-induced *ΔE-NOTCH1* tumor tissue (spleen; N=3). (E) Metabolite Set Enrichment Analysis (MSEA) was used to determine differentially enriched metabolite sets between normal thymic tissue and *ΔE-NOTCH1* tumors. The top 25 enriched pathways are shown. (F) Quantification of tissue BCAA (isoleucine, leucine and valine) and BCKA (3-methyl-2-oxovaleric acid, KMV) in thymic tissue (N=3) obtained from 6 weeks old C57/Bl6 mice and NOTCH1-induced *ΔE-NOTCH1* tumor tissue (spleen; N=3). Significance was calculated using an unpaired two-tailed t-test. **P*< 0.05, ***P*< 0.01. (G) Expression levels (qRT-PCR) of *Lat1* (*slc7a5*) in thymocytes obtained from 6-8 weeks old C57/Bl6 mice and leukemic cells from six *ΔE-NOTCH1* T-ALL tumors (NOTCH1-T). Significance was calculated using an unpaired two-tailed t-test. **P< 0.01. (H) Heat map showing the expression levels of BCAT1 (two probes), BCAT2 and HES1 (surrogate of activated NOTCH1) between healthy human thymic subpopulations and total thymus and diagnostic pediatric T-ALL samples (N=32). SP8=CD8 single positive, DP= CD3 negative CD4 and CD8 double positive, SP4= CD4 single positive, Thy=total thymus, DP3= CD3 positive CD4 and CD8 double positive, ISP=intermediate single positive, DN= CD4 and CD8 double negative. (I) BCAT1 expression levels in immunophenotypically distinct T-ALL subtypes (pre-cortical, cortical and post-cortical). Significance was calculated using a nonparametric t-test (Mann-Whitney). **P*< 0.05, ****P*< 0.001. (J) BCAT1 expression levels in *NOTCH1/FBXW7* wild-type (wt) and *NOTCH1/FBXW7* mutated (mut) T-ALL in COG ALL TARGET cohort[14]. Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01. (K) BCAT1 expression levels in *NOTCH1/FBXW7* wt (wt) and *NOTCH1/FBXW7* mutated (mut) T-ALL in GSE14959 cohort (N=37)[10]. Two different probes are shown. Significance was calculated using a nonparametric t-test (Mann-Whitney). **P*< 0.05, ***P*< 0.01. (L) BCAT1 expression levels in NOTCH1 wild-type (wt) and NOTCH1 activated (*NOTCH1/FBXW7* mutated) T-ALL (adult and pediatric) (CGAS00000000002)[11]. Significance was calculated using an unpaired two-tailed t-test. **P*< 0.05. (M) Western blot analysis of ICN1, BCAT1, HES1, MYC, BCAT2, PTEN in T-ALL cell lines. Tubulin and β-actin are shown as loading controls. Cell lines with un-mutated NOTCH1 (wt) or activated NOTCH1 signaling (mutated/translocated) are shown. Arrow indicates specific band. (N) Correlation analysis between expression levels of BCAT1 and HES1 in T-ALL cell lines (ALL-SIL, CCRF-HSB2, DND41, HPB-ALL, Jurkat, PF-382, P12-Ichikawa, RPMI8402, MOLT4, CCRF-CEM, MOLT-3, MOLT-16; N=12) from GSE168386[28]. (O) Schematic drawing of BCAT1 gene structure (left) with amplicon coordinates indicated (UCSC Genome browser GRCh38/hg38 version). Methylated cytosines residing in CpG sites are depicted as red lines. (P) Methylation specific PCR (MSP) of BCAT1 promoter T1[29, 30]was set-up and used to evaluate methylation status of BCAT1 in T-ALL cell lines. Primer sets used for amplification are designated as unmethylated (U) and methylated (M). A bisulphite-conversion specific beta-actin gene (*ACTB*) PCR assay was performed as control assay to evaluate total amount of analyzed DNA. All DNA samples were bisulfite-treated. Relative BCAT1 transcript levels of the analyzed T-ALL cell lines are also shown (lower panel). BCAT1 expression is relative to a human thymocyte sample (#1).

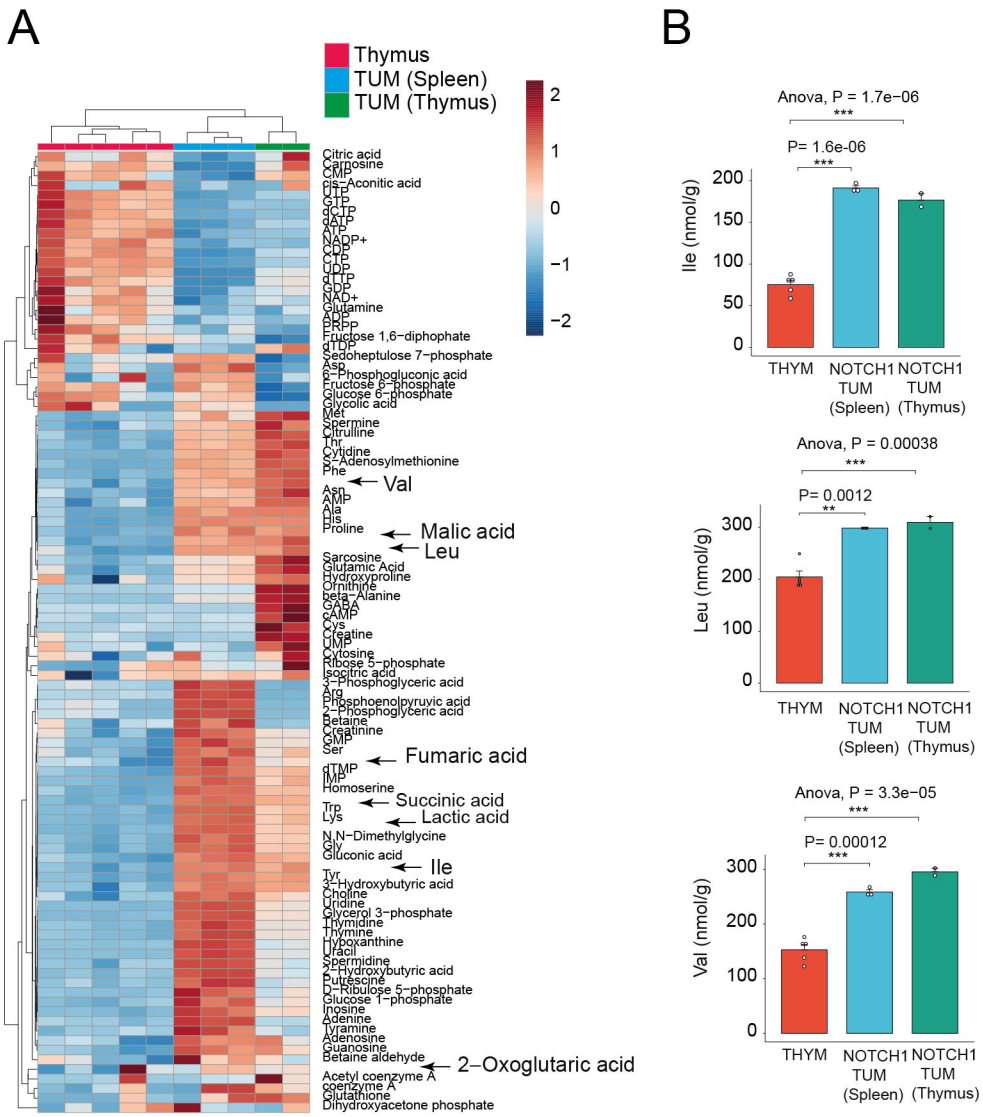
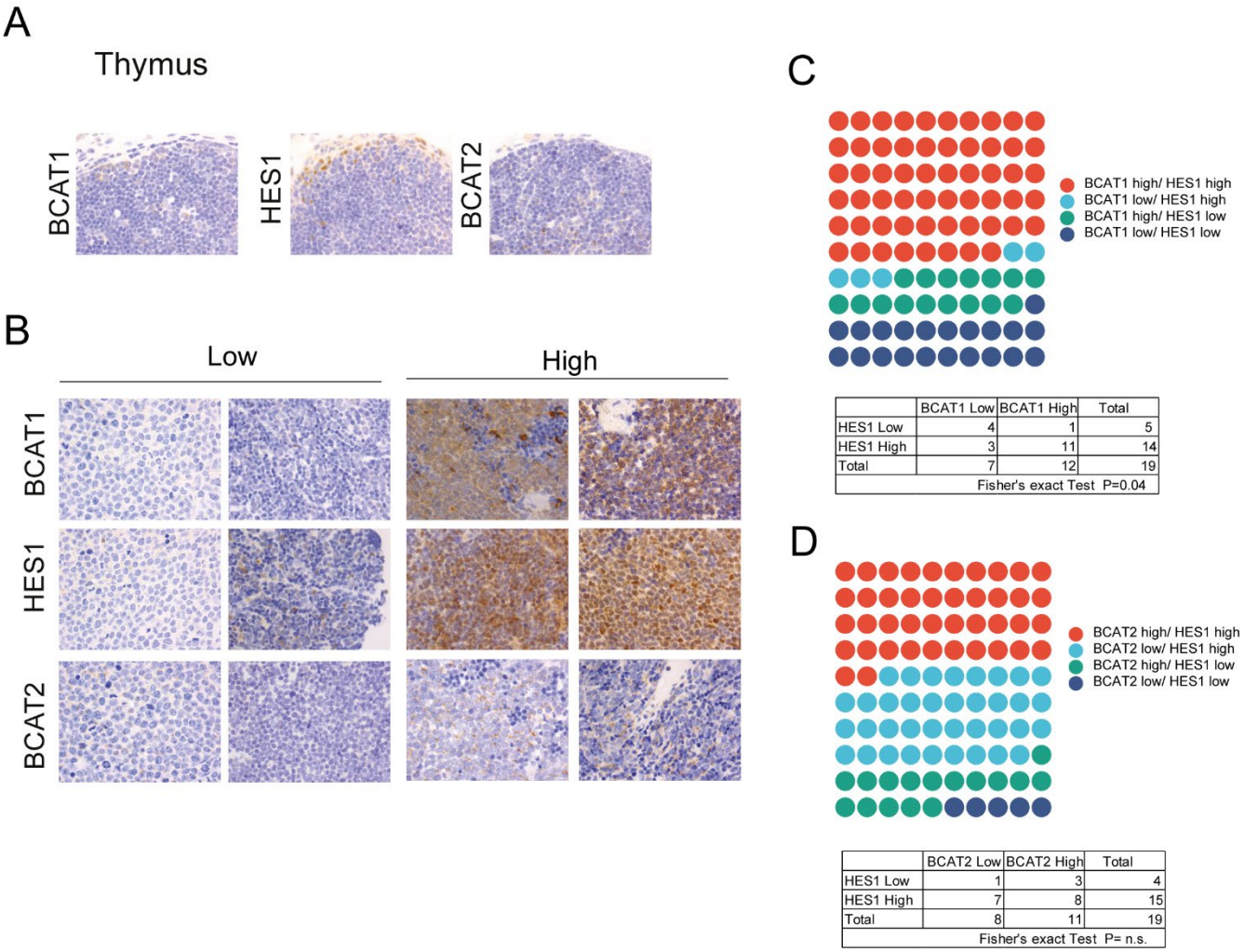


Figure S2. *ΔE-NOTCH1* tumors derived from infiltrated spleen and thymus have a similar metabolic profile. (A) Heatmap representation of metabolites identified by capillary electrophoresis time-of-flight mass spectrometry (CE-TOFMS) of thymic tissue (N=5) obtained from 6 weeks old C57/Bl6 mice and NOTCH1-induced *ΔE-NOTCH1* tumor tissue (spleen; N=3 or thymus; N=2). Selected metabolites differentially expressed between normal and leukemic tissue are remarked. (B) Quantification of tissue BCAA (isoleucine, leucine and valine) in thymic tissue (N=5) obtained from 6 weeks old C57/Bl6 mice and NOTCH1-induced *ΔE-NOTCH1* tumor tissue (spleen; N=3 or thymus; N=2). Significance was calculated using an unpaired two-tailed t-test or ANOVA test (normal versus leukemia). $^{**}P< 0.01$, $^{***}P< 0.001$.



	BCAT1 Low	BCAT1 High	Total
HES1 Low	4	1	5
HES1 High	3	11	14
Total	7	12	19
Fisher's exact Test P=0.04			

	BCAT2 Low	BCAT2 High	Total
HES1 Low	1	3	4
HES1 High	7	8	15
Total	8	11	19
Fisher's exact Test P= n.s.			

Figure S3. BCAT1 expression associates with NOTCH1 activation in human T-ALL. (A) BCAT1 (left), HES1 (middle) and BCAT2 (right) immunohistochemical staining of human thymus (top): original magnification 400×. (B) Immunohistochemical staining for BCAT1 (top), HES1 (middle), and BCAT2 (bottom) in representative cases of T-ALL showing low (0, +1) and high (+2, +3) expression levels. Original magnification ×400. (c) Circle waffle representation of BCAT1 immunohistochemical staining results obtained in T-ALL/T-LBL/PDX samples analysed (top) and correlation table for Fisher's exact test (bottom). (D) Circle waffle representation of BCAT2 immunohistochemical staining results obtained in T-ALL/T-LBL/PDX samples analysed (top) and correlation table for Fisher's exact test (bottom).

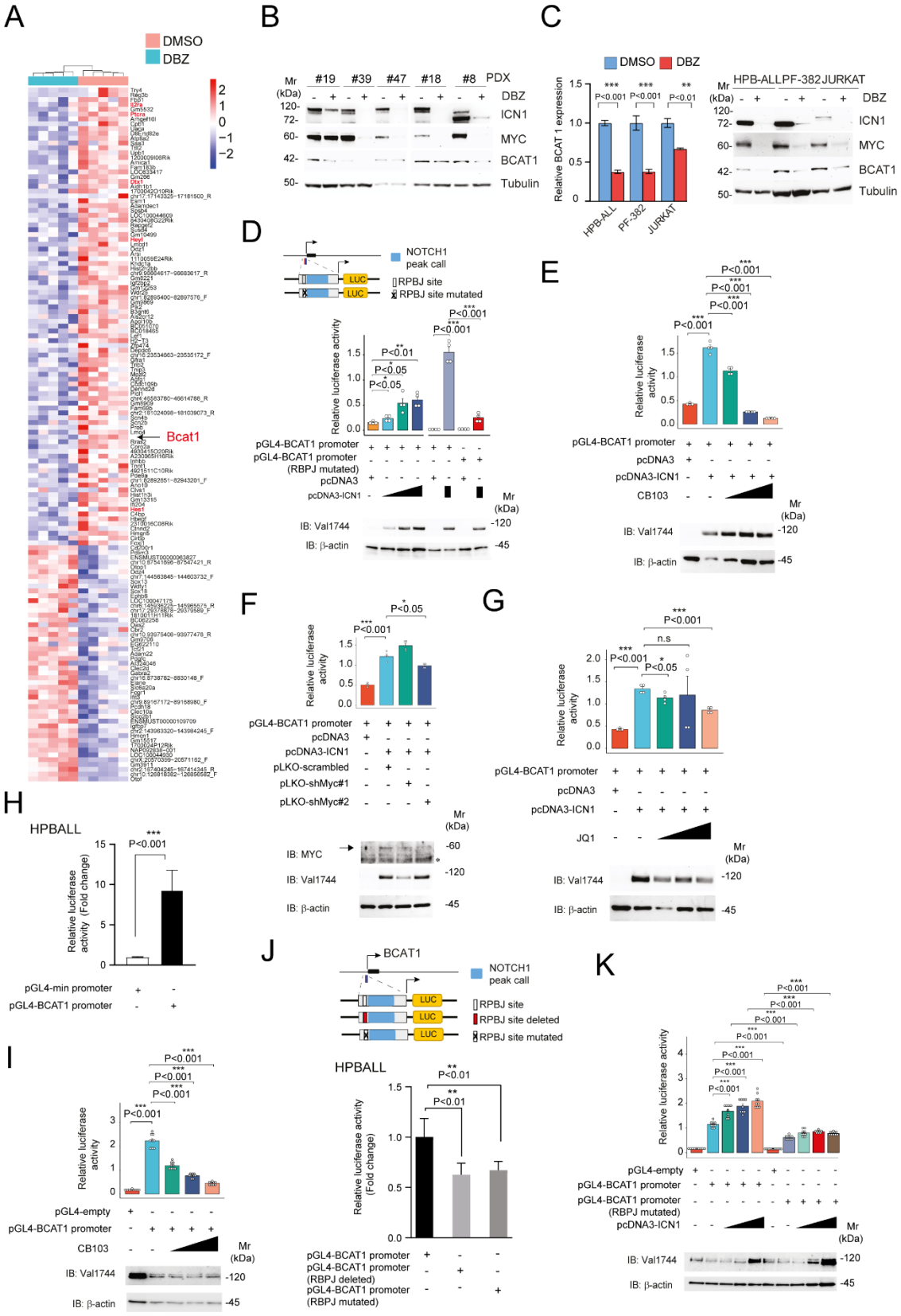


Figure S4. BCAT1 is modulated upon NOTCH1 inhibition. (A) Heat map representation of the top down-regulated genes following in vivo DBZ treatment of five *ΔE-NOTCH1* tumors. BCAT1 and selected known

NOTCH1 target genes are shown[1]. (B) PDX samples were treated in vivo with DBZ (10 μg/kg every 8 hours for a total of 3 injections) or vehicle (DMSO) for 24h before analysis of BCAT1 protein levels. ICN1 and MYC proteins are also shown. Tubulin is shown as loading control. (C) T-ALL cell lines were treated with DBZ (250 nM) or vehicle for 72h before analysis of BCAT1 transcript (left) or BCAT1 protein levels (right). ICN1 and MYC proteins are also shown. Tubulin is shown as loading control. Mean value and SD are shown. For statistical analysis, an unpaired t-test was used. $^{**}P< 0.01$. $^{***}P< 0.001$. (D) Schematic representation (top) of *BCAT1* promoter construct (BCAT1-Luc) containing the region –1407 to +195 from the transcription start site (TSS) including the proximal RBPJ binding site. The location of the NOTCH1 ChIP peak is also depicted on the reporter construct. HEK 293T cells were co-transfected with pGL4 luciferase reporter construct (BCAT1-Luc) and different amounts of pcDNA3-ICN1 or control plasmid. In some experiments, HEK 293T cells were also co-transfected with BCAT1-Luc having the RBPJ site mutated and ICN1 plasmid. Immunoblot shows expression levels of ICN1 in transfected cells. β-actin is shown as loading control. Error bars indicate ± SD. Results from one of two independent experiments performed in quadruplicate are shown. Significance was calculated using an unpaired two-tailed t-test. $^{*}P< 0.05$, $^{**}P< 0.01$, $^{***}P< 0.001$. (E) HEK 293T cells were co-transfected with pGL4 luciferase reporter construct (BCAT1-Luc) and ICN1 or control plasmid. After 24h, ICN1 transfected cells were treated with increasing concentration of CB103 (10 nM-1 μM) or vehicle for 48h. Immunoblot shows expression levels of ICN1 in transfected cells. β-actin is shown as loading control. Error bars indicate ± SD. Results from one of two independent experiments performed in quadruplicate are shown. Significance was calculated using an unpaired two-tailed t-test. $^{***}P< 0.001$. (F) HEK 293T cells were co-transfected with pGL4 luciferase reporter construct (BCAT1-Luc) and ICN1 or control plasmid. After 24h, ICN1 transfected cells were transfected with plasmids silencing MYC (pLKO-shMYC#1, pLKO-shMYC#2) or non-silencing control (pLKO-shscrambled). Cells were harvested 48h later. Immunoblot shows expression levels of MYC and ICN1 in transfected cells. β-actin is shown as loading control. Arrow indicates specific band. Asterisc (*) indicates non-specific band. Error bars indicate ± SD. Results from one of two independent experiments performed in quadruplicate are shown. Significance was calculated using an unpaired two-tailed t-test. $^{*}P< 0.05$, $^{***}P< 0.001$. (G) HEK 293T cells were co-transfected with pGL4 luciferase reporter construct (BCAT1-Luc) and ICN1 or control plasmid. After 24h, ICN1 transfected cells were treated with increasing concentrations of JQ1 (10 nM-1 μM) or vehicle for 48h. Immunoblot shows expression levels of ICN1 in transfected cells. β-actin is shown as loading control. Error bars indicate ± SD. Results from one of two independent experiments performed in quadruplicate are shown. Significance was calculated using an unpaired two-tailed t-test. $^{*}P< 0.05$, $^{***}P< 0.001$. n.s=not significant. (H) Relative luciferase reporter activity in HPB T-ALL cells transfected with a BCAT1 promoter construct (BCAT1-Luc) or empty pGL4minP plasmid. Mean value and SD are shown (N =6). For statistical analysis, an unpaired t-test was used. $^{***}P< 0.001$. The experiment was repeated three times with similar results. (I) Relative luciferase reporter activity in HPB T-ALL cells transfected with pGL4 luciferase reporter construct (BCAT1-Luc) or control plasmid. After 24h, transfected cells were treated with increasing concentration of CB103 (0.5 μM-5 μM) or vehicle for 48h. Immunoblot shows expression levels of ICN1 in transfected cells. β-actin is shown as loading control. Error bars indicate ± SD. Results from one of two independent experiments performed is shown. Significance was calculated using an unpaired two-tailed t-test. $^{***}P< 0.001$. (J) Relative luciferase reporter activity in HPB T-ALL cells transfected with BCAT1-Luc wt construct, BCAT1-Luc having the RBPJ site deleted or mutated. Mean value and SD are shown (N=6). For statistical analysis, an unpaired t-test was used. $^{**}P< 0.01$. The experiment was repeated three times with similar results. (K) Relative luciferase reporter activity in HPB T-ALL cells transfected with BCAT1-Luc wt construct, BCAT1-Luc having the RBPJ site mutated or control vector. These cells were co-transfected with increasing concentrations of pcDNA3-ICN1 or control plasmid (100-500 ng). Error bars indicate ± SD. For statistical analysis, an unpaired t-test was used. $^{***}P< 0.001$. Immunoblot shows expression levels of ICN1 in transfected cells. β-actin is shown as loading control.

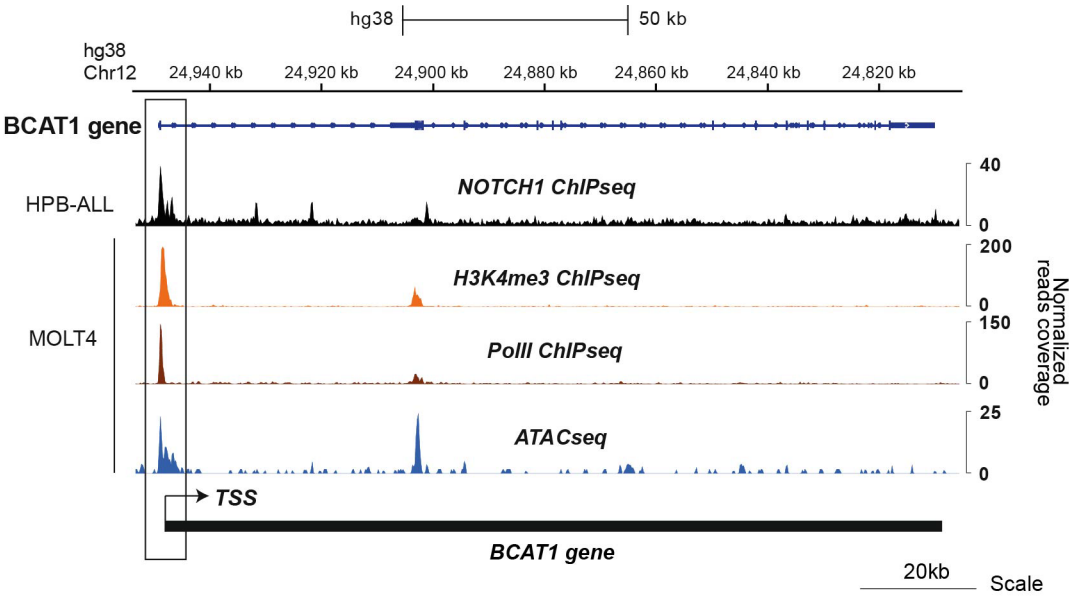


Figure S5. The NOTCH1 binding region in the BCAT1 locus is associated with promoter features in T-ALL cells. Profiles of H3K4me3, Pol II and NOTCH1 ChIP-seq binding in the BCAT1 locus in T-ALL cells. ATAC-seq data for the same region is also shown.

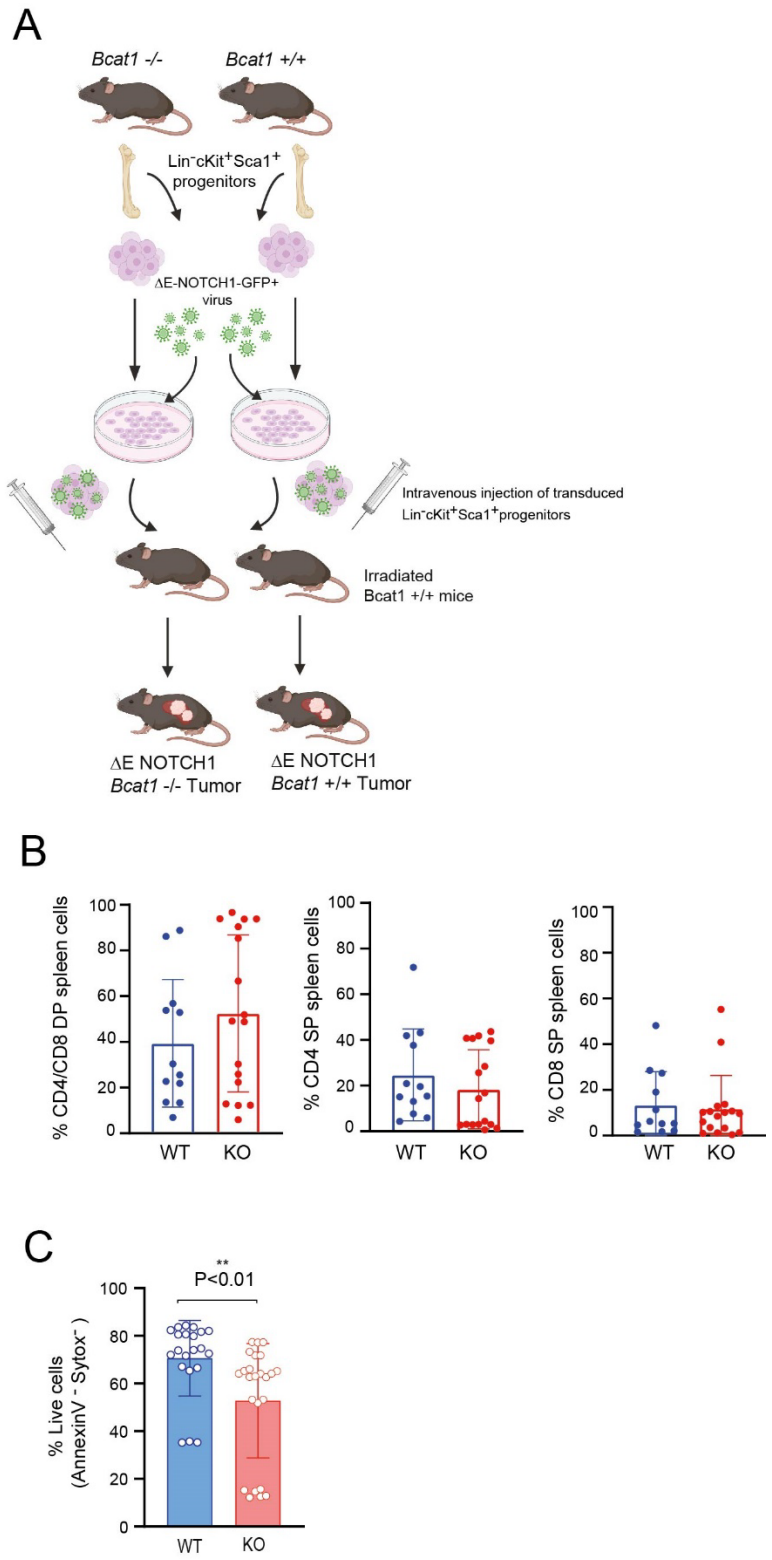


Figure S6. Bcat1 promotes NOTCH1-dependent leukemia onset. (A) Schematic representation of the experimental procedure for the generation of *ΔE-NOTCH1* leukemias wild-type (WT; +/+) and null (KO; -/-) for *Bcat1*. Image was generated with BioRender software. (B) Immunophenotype distribution showing the expression levels of CD4 and CD8 in *ΔE-NOTCH1*-induced leukemias at the moment of sacrifice. DN, double negative; DP,

double positive; SP, single positive. WT, *Bcat1* wild-type; KO, *Bcat1* null. (C) Quantification of viable cells (Annexin V^- Sytox Red^-) in *ΔE-NOTCH1* leukemias WT and null for *Bcat1* obtained ex vivo (bar graph). Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. $^{**}P < 0.01$.

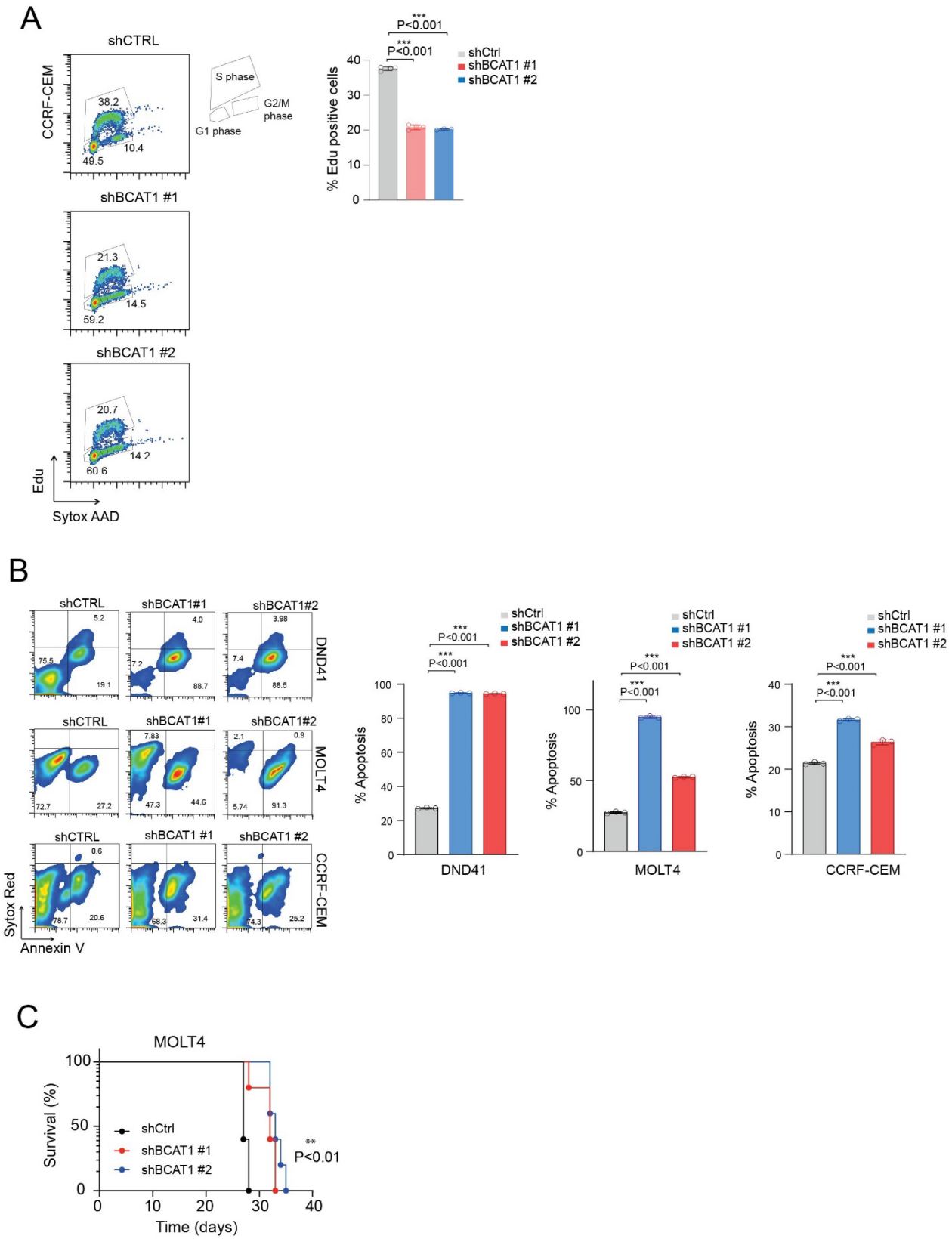


Figure S7. Functional effects of BCAT1 depletion. (A) Representative plots (left) and bar graph representation (right) of CCRF-CEM cells transduced with shCTRL, shBCAT1#1 or shBCAT1#2 twelve days post-puromycin

selection and assessed for EdU incorporation by fluorescence-activated cell sorting (FACS) analysis. Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ***$P< 0.001$. (B) Representative plots of apoptosis (left) and quantification of apoptosis (right) in in DND41, MOLT4 and CCRF-CEM T-ALL cells transduced with shCTRL, shBCAT1 #1 and shBCAT1 #2 constructs 3-5 days post-puromycin selection. Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ***$P< 0.001$. (C) Kaplan-Meier survival curves of overall survival in NSG mice xenografted with MOLT4 cells expressing luciferase and transduced with shCTRL or shBCAT1 (#1 and #2). Log-rank test was performed to calculate *P* value. **$P< 0.01$.

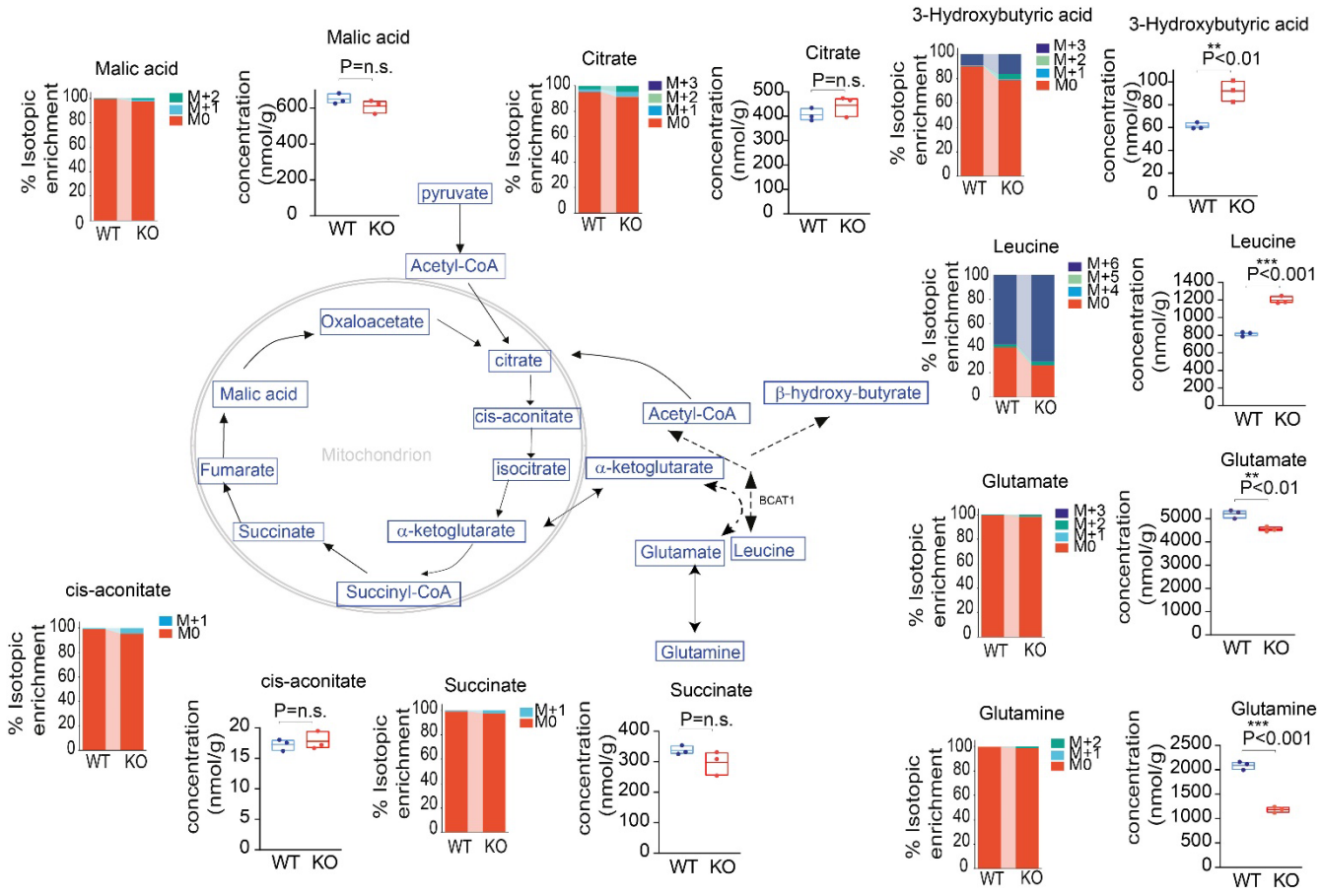


Figure S8. **Metabolic impact of Bcat1 depletion on *ΔE-NOTCH1* leukemias.** Results for *in vivo* isotope-tracing experiments following i.v. administration of $^{13}C_6$ Leu in *ΔE-NOTCH1* leukemias WT and KO for *Bcat1*. Mean percentages (from N=3 determinations) of $^{13}C_6$ Leu derived: (i) TCA intermediates: citrate (M0, M+1, M+2, M3), cis-aconitate, (M0, M+1), malic acid (M0, M+1, M+2), succinate (M0, M+1); (ii) BCAA and derivatives: leucine (M0, M+4, M+5, M+6), glutamate (M0, M+1, M+2, M3), glutamine (M0, M+1, M+2) and beta-hydroxybutyrate (M0, M+1, M+2, M+3) are shown. F-scope metabolic quantification for selected metabolites in the same tumors is also shown. Changes in glutaminolysis, TCA cycle intermediates, and BCAA and intermediates are shown as floating bars representing mean ± SD. Significance was calculated using a nonparametric t-test (Mann-Whitney). **P*< 0.05, ***P*< 0.01, ***P< 0.001. n.s.= not significant.

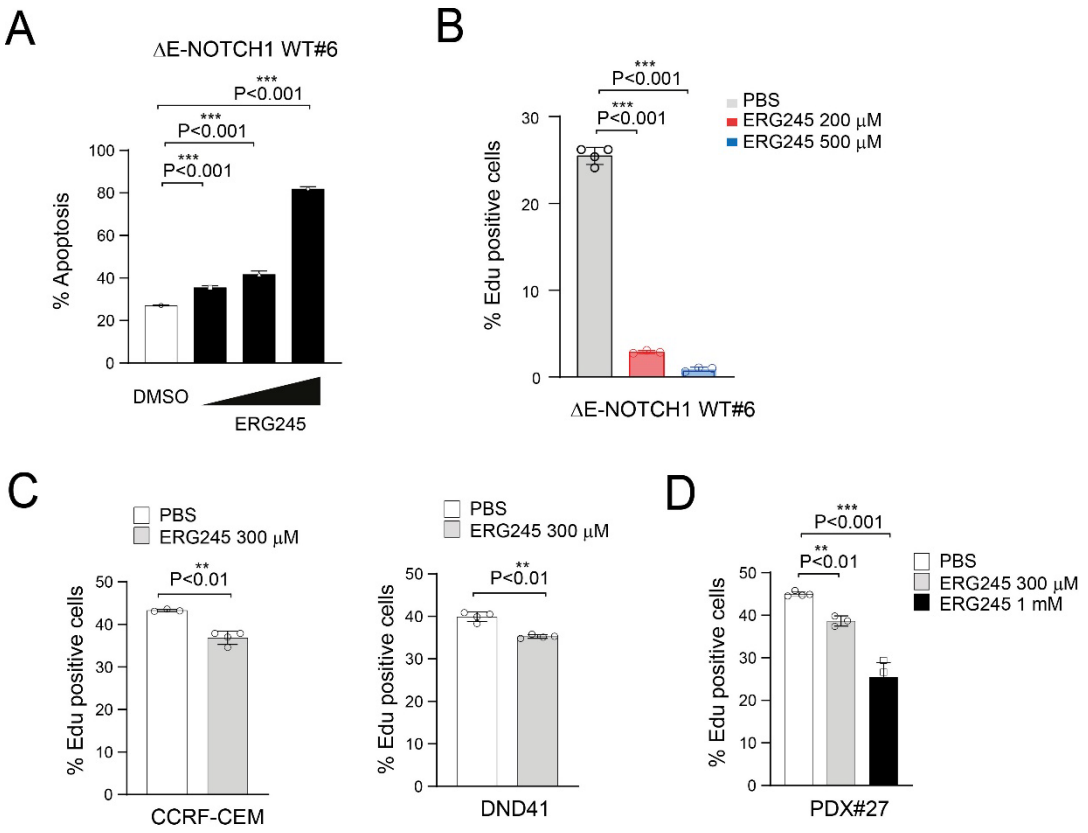


Figure S9. Functional effects of a BCAT1 specific inhibitor, ERG245. (A) Quantification of apoptosis in *ΔE-NOTCH1* leukemia wild-type for *Bcat1* (WT#6) treated in vitro for 48h with PBS (vehicle) or increasing doses of ERG245 (200 μM-1 mM). Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ****P*< 0.001. (B) Quantification of EdU incorporation (S-phase cells) in *ΔE NOTCH1* leukemia wild-type for Bcat1 (WT#6) treated in vitro for 48h with PBS (vehicle) or increasing doses of ERG245 (200 μM- 500 μM). Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ****P*< 0.001. (C) Quantification of EdU incorporation (S-phase cells) in T-ALL cell lines (CCRF-CEM, DND41) treated in vitro for 72h with PBS (vehicle) or ERG245 (300 μM). Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01. (D) Quantification of EdU incorporation (S-phase cells) in PDX#27 treated in vitro for 72h with PBS (vehicle) or increasing doses of ERG245 (300 μM-1 mM). Data for bar graph is shown as mean ± SD. Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01, ****P*< 0.001.

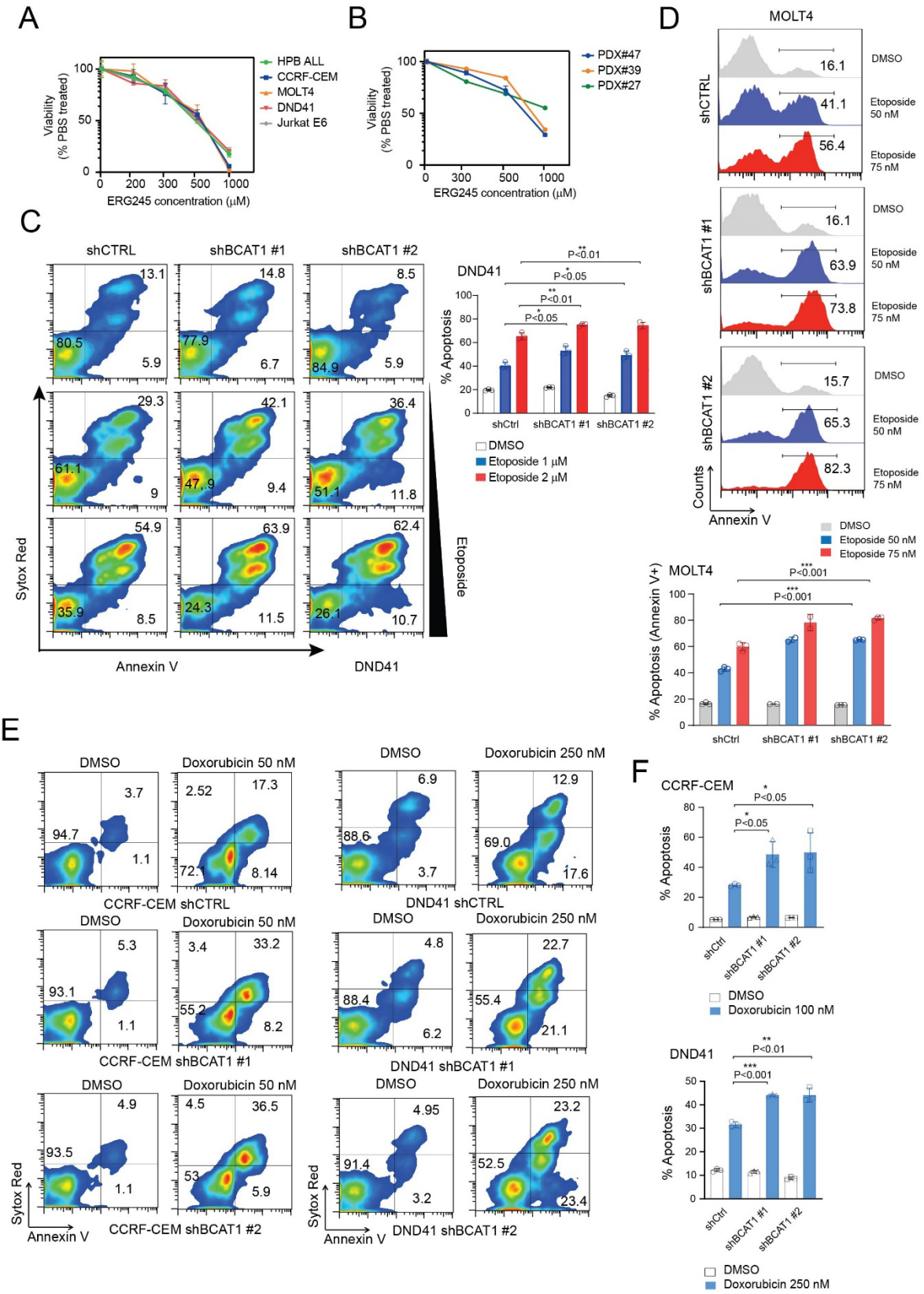


Figure S10. BCAT1 specific inhibition has modest cytotoxic effects on human T-ALL, while BCAT1 depletion increases sensitivity to DNA damaging agents. (A) Cell viability analysis in T-ALL cell lines (HPB-

ALL, CCRF-CEM, MOLT4, DND41, Jurkat E6). T-ALL cells were treated in vitro for 72h with PBS (vehicle) or increasing doses of ERG245 (200 μM-1 mM). Data is shown as mean ± SD. (B) Cell viability analysis in PDX samples (PDX#47, PDX#39, PDX#27). T-ALL cells were treated in vitro for 72h with PBS (vehicle) or increasing doses of ERG245 (300 μM-1 mM). Data is shown as mean ± SD. (C) Representative plots of apoptosis (left) in DND41 T-ALL cells transduced with shCTRL or shBCAT1 (#1 and #2) and treated in vitro for 48h with DMSO (vehicle) or etoposide (1 μM or 2 μM). Quantification of apoptosis (right) in DND41 T-ALL cells transduced with shCTRL or shBCAT1 (#1 and #2) and treated in vitro for 48h with DMSO (vehicle) or etoposide (1 μM or 2 μM). Significance was calculated using an unpaired two-tailed t-test. * $P< 0.05$, ** $P< 0.01$. (D) Representative plots (top) and bar graph representation (bottom) of annexin V staining in MOLT4 T-ALL cells transduced with shCTRL or shBCAT1 (#1 and #2) and treated with vehicle (DMSO) or etoposide (Etop; 50-75 nM) for 48h. (E) Representative plots of apoptosis in CCRF-CEM (left) or DND41 (right) T-ALL cells transduced with shCTRL, shBCAT1#1 or shBCAT1#2 and treated with vehicle (DMSO) or doxorubicin (Doxo; 50 or 250 nM, respectively) for 48h. (F) Bar graph representation of apoptosis in CCRF-CEM (top) or DND41 (bottom) T-ALL cells transduced with shCTRL, shBCAT1#1 or shBCAT1#2 and treated with vehicle (DMSO) or doxorubicin (Doxo; 50 or 250 nM, respectively) for 48h. Significance was calculated using an unpaired two-tailed t-test. * $P< 0.05$, ** $P< 0.01$, *** $P< 0.001$.

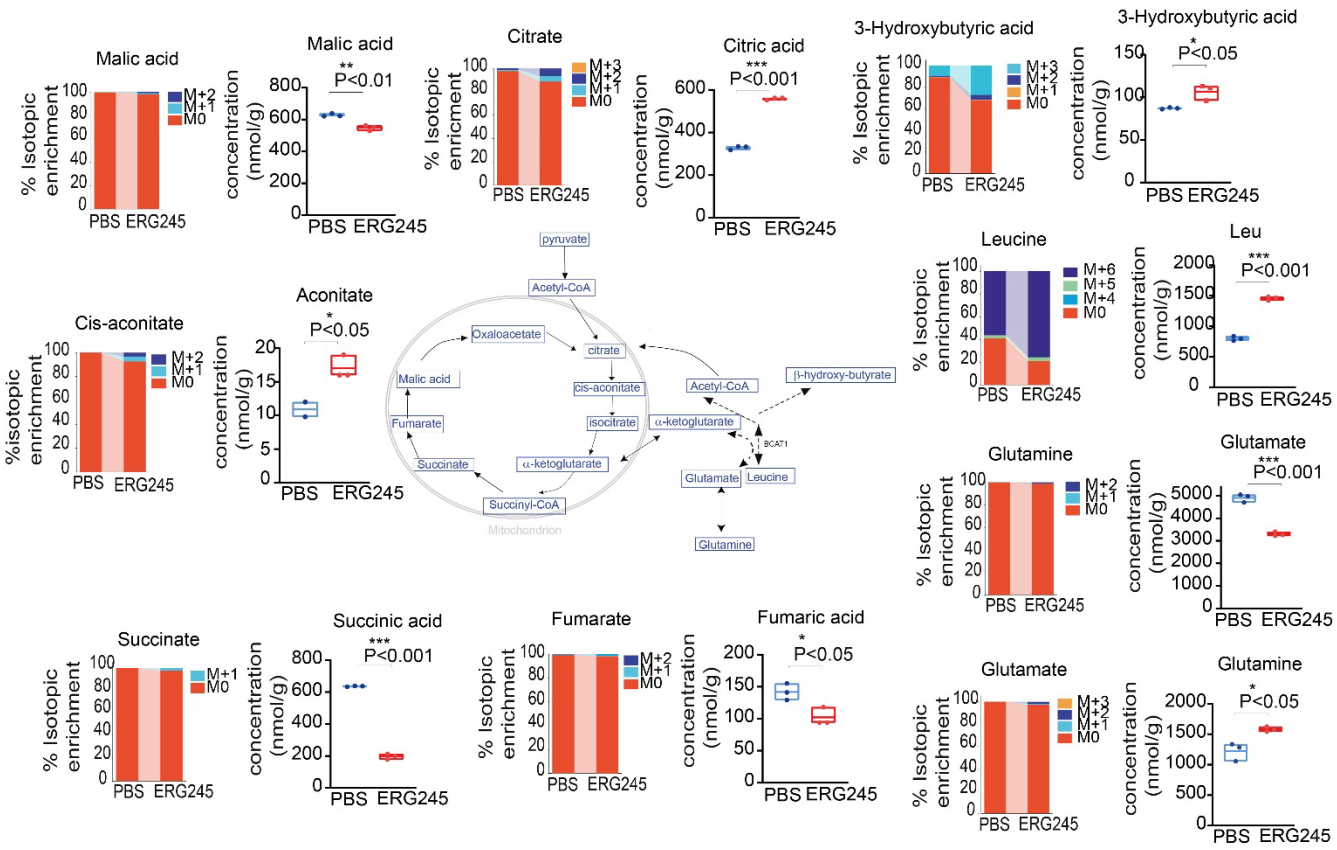


Figure S11. Metabolic impact of BCAT1 inhibition on *ΔE-NOTCH1* leukemias. Results for *in vivo* isotope-tracing experiments following i.v. administration of $^{13}C_6$ Leu in primary *ΔE-NOTCH1* leukemic tissue (N=3) treated with vehicle (PBS) or BCAT1-specific inhibitor, ERG245 (30 mg/kg every 8 hours for 24h). Percentages of $^{13}C_6$ Leu derived: (i) TCA intermediates: citrate (M0, M+1, M+2, M3), cis-aconitate, (M0, M+1, M+2), fumarate (M0, M+1, M+2), malic acid (M0, M+1, M+2), succinate (M0, M+1); (ii) BCAA and derivatives: leucine (M0, M+4, M+5, M+6), glutamate (M0, M+1, M+2, M3), glutamine (M0, M+1, M+2) and beta-hydroxybutyrate (M0, M+1, M+2, M3) are shown. F-scope metabolic quantification for selected metabolites in the same tumors is also shown. Changes in glutaminolysis, TCA cycle intermediates, and BCAA and intermediates are shown as floating bars representing mean ± SD. Significance was calculated using a nonparametric t-test (Mann-Whitney). **P*< 0.05, ***P*< 0.01, ***P< 0.001. n.s.= not significant

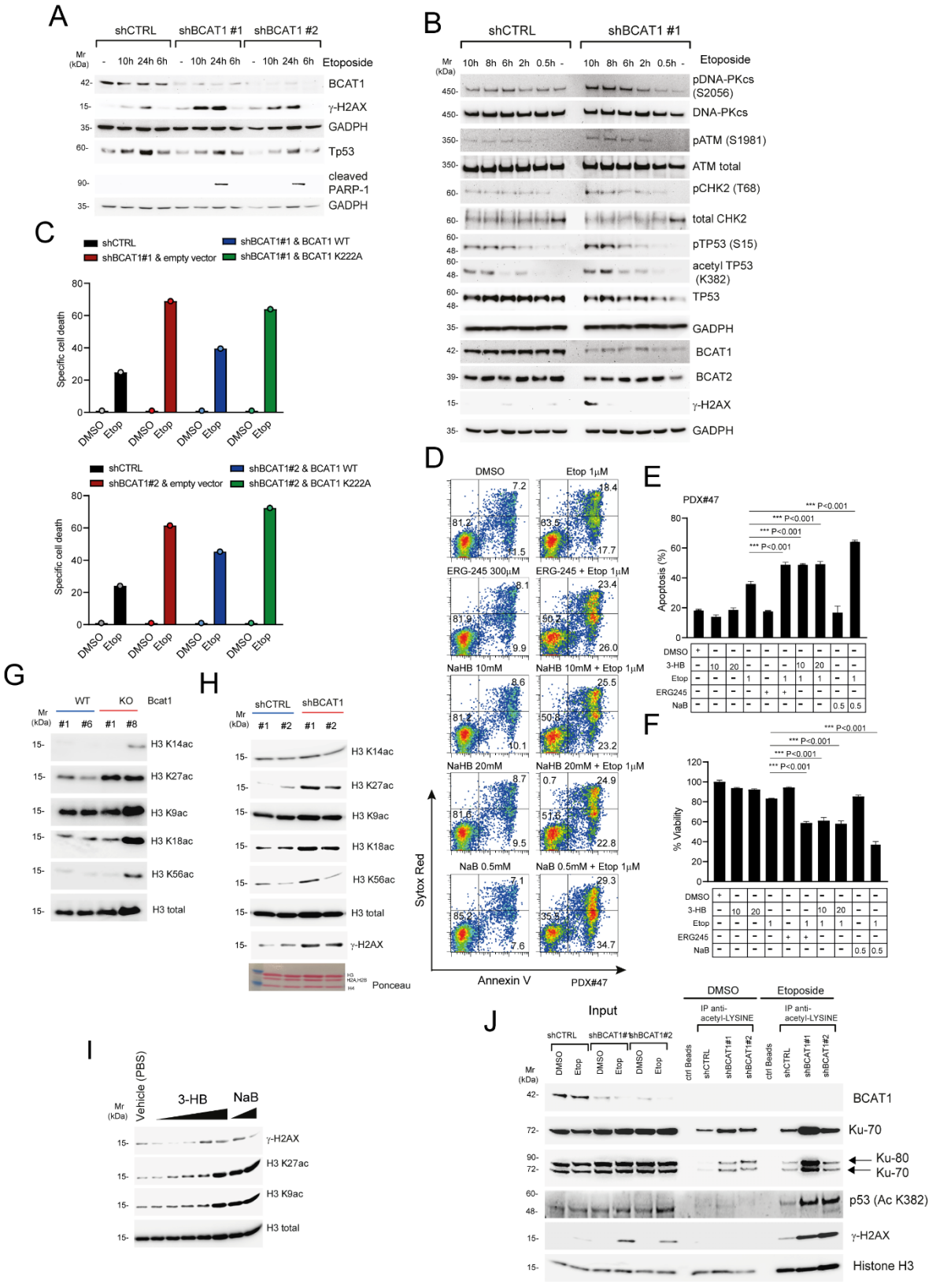


Figure S12. Increased responsiveness to DNA damaging agents in BCAT1 depleted cells is associated with an altered DNA damage response and dependent on its catalytic activity. (A) CCRF-CEM T-ALL cells

transduced with shCTRL or shBCAT1 (#1 and #2) were treated with 1 μM etoposide for the indicated time. Subsequently, whole cell lysates were collected and analyzed by immunoblotting for proteins implicated in the DNA damage response and apoptosis (γH2AX, TP53, cleaved PARP-1). GADPH is shown as loading control. (B) CCRF-CEM T-ALL cells transduced with shCTRL or shBCAT1 #1 were treated with 1 μM etoposide for the indicated time (0-10 hours). Subsequently, whole cell lysates were collected and analyzed by immunoblotting for proteins implicated in the DNA damage response. Total DNA-PKcs, ATM, CHK2 and GADPH are shown as loading controls. (C) Specific apoptosis[31] analysis in BCAT1 depleted CCRF-CEM T-ALL cells (shBCAT1#1 or shBCAT1#2) engineered to express empty vector, wild-type (WT) or catalytic inactive (K222A) BCAT1 and treated in vitro for 48h with DMSO (vehicle) or etoposide (1 μM). Specific apoptosis analysis of CCRF-CEM cells infected with a control shRNA (shCTRL) and treated in vitro for 48h with DMSO (vehicle) or etoposide (1 μM) is also shown. Significance was calculated using an unpaired two-tailed t-test. ** $P< 0.01$, *** $P< 0.001$. (D) Representative plots of apoptosis in PDX#47 cells treated with vehicle (DMSO), 3-HB (10-20 mM), NaB (0.5 mM), ERG245 (300 μM) etoposide (Etop; 1 μM)) or the combination (ERG245 + Etop or 3-HB + Etop or NaB + Etop) for 48h. (E) Quantification of apoptosis in PDX#47 cells treated in vitro with vehicle (DMSO), 3-HB (10-20 mM), NaB (0.5 mM), ERG245 (300 μM), etoposide (Etop; 1 μM)) or the combination (3-HB + Etop or ERG245 + Etop or NaB + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. *** $P< 0.001$. (F) Cell viability analysis in PDX#47 cells treated in vitro with vehicle (DMSO), 3-HB (10-20 mM), NaB (0.5 mM), ERG245 (300 μM), etoposide (Etop; 1 μM)) or the combination (3-HB + Etop or ERG245 + Etop or NaB + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. *** $P< 0.001$. (G) Total histones were extracted from tumors WT or KO for *Bcat1* and immunoblots were performed for acetylated histone H3 variants. Total H3 is shown as loading control. (H) Total histones extracted from CCRF-CEM cells transduced with shCTRL (#1, #2) or shBCAT1 (#1 and #2) were analyzed by immunoblotting for acetylated histone H3 variants and γH2AX. Total H3 and Ponceau staining are shown as loading controls. (I) CCRF-CEM TALL cells were treated for 24h with vehicle or increasing concentrations of 3-HB (1-40 mM) or NaB (0.5-1 mM). Total histones were extracted and analyzed by immunoblotting for selected acetylated histone H3 variants (K27ac, K9ac) and γH2AX. Total H3 is shown as loading control. (J) CCRF-CEM T-ALL cells transduced with shCTRL or shBCAT1 (#1 and #2) were treated with vehicle (DMSO) or 1 μM etoposide for 24h, subsequently whole cell lysates were collected and immunoprecipitated using anti-acetyl-lysine affinity beads or control beads and probed for KU70, KU80, γH2AX. Total H3 was used as loading control (for input).

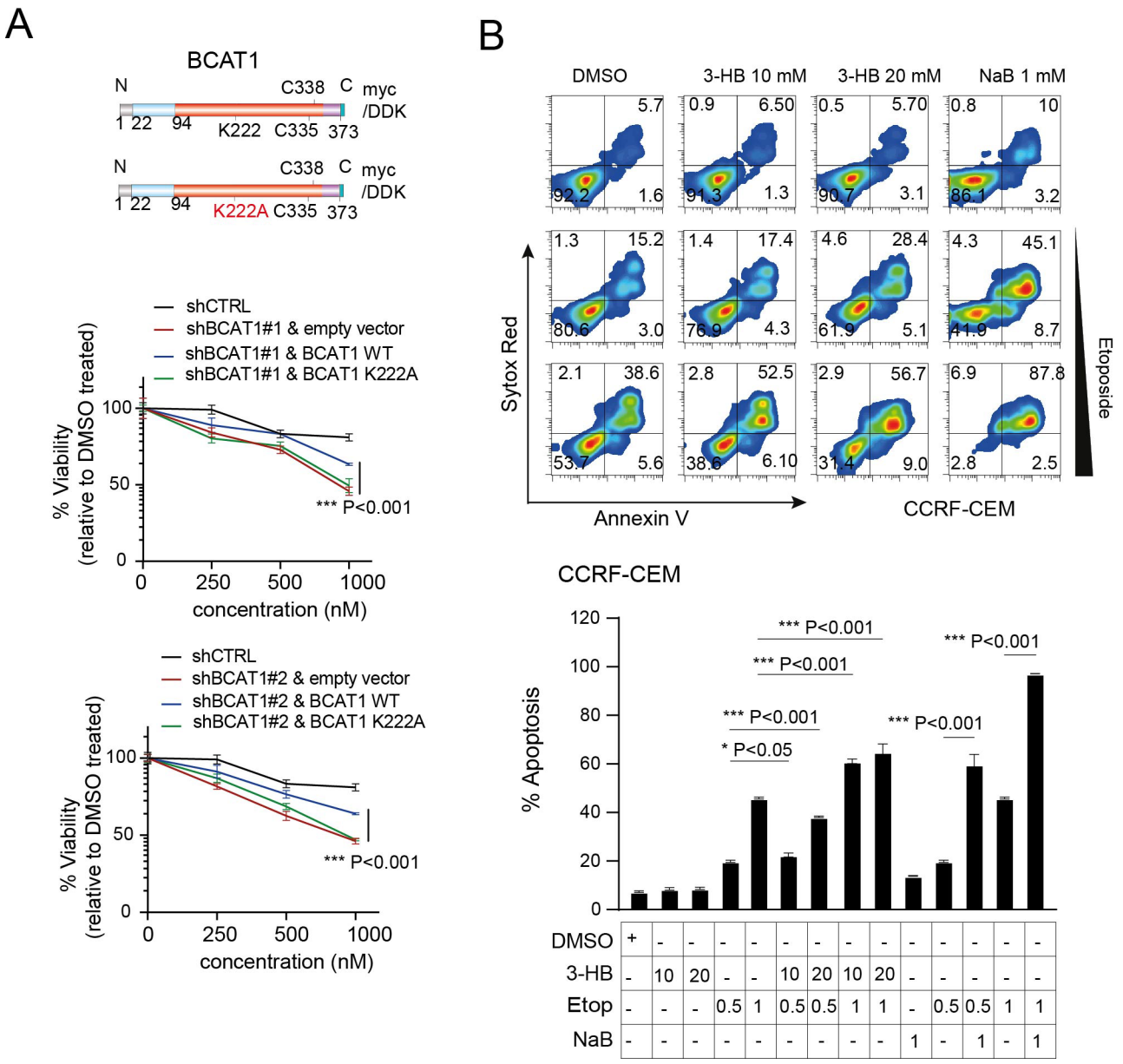


Figure S13. Metabolic function of BCAT1 contributes in modulating the sensitivity to DNA damaging agents. (A) Schematic representations (top) of the constructs encoding full-length (WT) and catalytic inactive mutant of BCAT1 (K222A). Cell viability analysis (lower panels) in BCAT1 depleted CCRF-CEM T-ALL cells (shBCAT1#1 or shBCAT1#2) engineered to express empty vector, wild-type (WT) or catalytic inactive (K222A) BCAT1 and treated in vitro for 48h with DMSO (vehicle) or etoposide (250 nM– 1 µM). Cell viability analysis of CCRF-CEM cells infected with a control shRNA (shCTRL) and treated in vitro for 48h with DMSO (vehicle) or etoposide (250 nM– 1 µM) is also shown. Significance was calculated using an unpaired two-tailed t-test. *** $P<$ 0.001. (B) Representative plots of apoptosis (top) or quantification of apoptosis (bottom) in CCRF-CEM T-ALL cells treated with vehicle (DMSO), 3-HB (10-20mM), NaB (1mM), etoposide (Etop; 0.5-1 µM) or the combination (3-HB + Etop or NaB + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. * $P<$ 0.05, *** $P<$ 0.001.

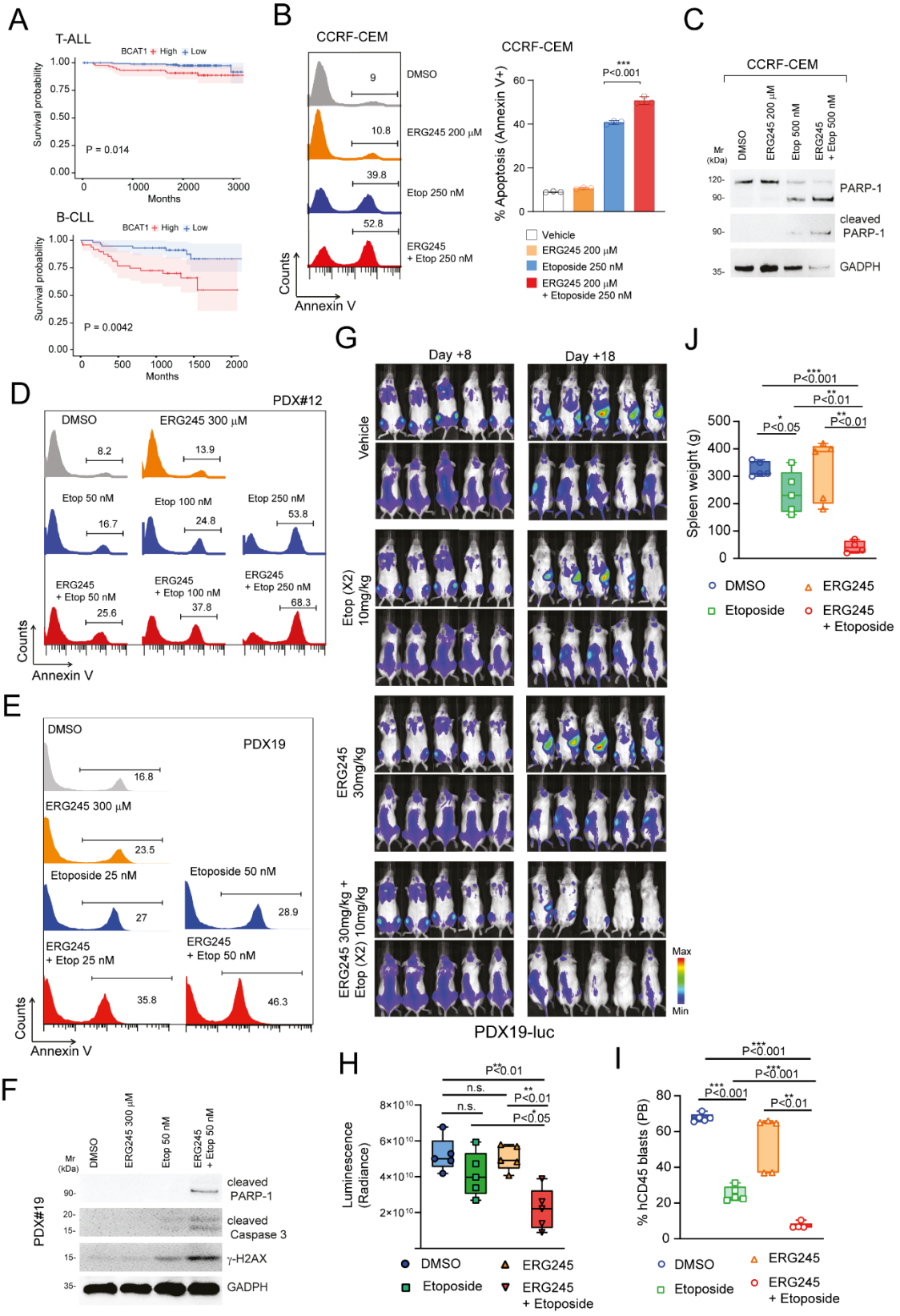


Figure S14. BCAT1 expression correlates with prognosis in NOTCH1-dependent leukemias and represents a therapeutic target in T-ALL. (A) Kaplan–Meier survival curves (top) of the entire series of 261 T-ALL patients

(with reported OS). BCAT1 high cases (> mean expression) or BCAT1 low cases (< mean expression). Log-rank Mantel-Cox test was performed to calculate *P* value. **P*< 0.05. Shaded area represents 95% CI. Kaplan–Meier survival curves of a cohort of 107 B-CLL patients (bottom). BCAT1 (probe 22585_at) high cases (> mean expression) or BCAT1 low cases (< mean expression). Log-rank Mantel-Cox test was performed to calculate *P* value. ***P*< 0.01. Shaded area represents 95% CI. (B) Representative plots (left) and bar graph representation (right) of annexin V staining in CCRF-CEM T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245), etoposide (Etop) or the combination (ERG245 + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. *** *P*< 0.001. (C) Western blot analysis of PARP-1 (total or cleaved PARP-1) in CCRF-CEM cells treated for 48h with DMSO (vehicle), ERG245 (200 μM), etoposide (Etop; 500 nM) or ERG245 + Etop. GADPH was used as protein loading control. (D) Representative plots of annexin V staining in PDX#12 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245; 300 μM), etoposide (Etop: 50, 100, 250 nM) or the combination (ERG245 + Etop) for 48h. (E) Representative plots of annexin V staining in PDX#19 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245; 300 μM), etoposide (Etop: 25, 50 nM) or the combination (ERG245 + Etop) for 48h. (F) Western blot analysis of cleaved PARP-1, cleaved caspase 3 and phosphorylated γH2AX in PDX#19 cells treated for 48h with DMSO (vehicle), ERG245 (300 μM), etoposide (Etop; 50 nM) or ERG245 + Etop. GADPH was used as protein loading control. (G) Representative images of bioluminescence in NSG mice xenografted with PDX#19 cells expressing luciferase (PDX#19-luc) and treated with vehicle (DMSO), BCAT inhibitor (ERG245; 30 mg/kg three times a week), etoposide (Etop; 10 mg/kg twice a week) or the combination (ERG245 + Etop). Analysis before (day 8 post-transplantation) and 10 days after start of treatment (day 18 post-transplantation) is shown. (H) Quantitative analysis of tumor load via in vivo bioluminescence imaging of NSG mice xenografted with PDX#19-luc 10 days after treatment with vehicle (DMSO), BCAT inhibitor (ERG245), etoposide (Etop) or the combination (ERG245 + Etop). Significance was calculated using an unpaired two-tailed t-test. n.s: not significant. **P*<0.05, ** *P*<0.01. (I) Quantitative analysis of tumor burden in NSG mice xenografted with PDX#19-luc and treated with vehicle (DMSO), BCAT inhibitor (ERG245), etoposide (Etop) or the combination (ERG245+Etop), estimated by analyzing human CD45 expression in the blood (PB) at sacrifice (t=18 days). Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01, *** *P*< 0.001. (J) Analysis of spleen weight in NSG mice xenografted with PDX#19-luc and treated with vehicle (DMSO), BCAT inhibitor (ERG245), etoposide (Etop) or the combination (ERG245+Etop). Significance was calculated using an unpaired two-tailed t-test. **P*< 0.05, ***P*< 0.01, *** *P*< 0.001.

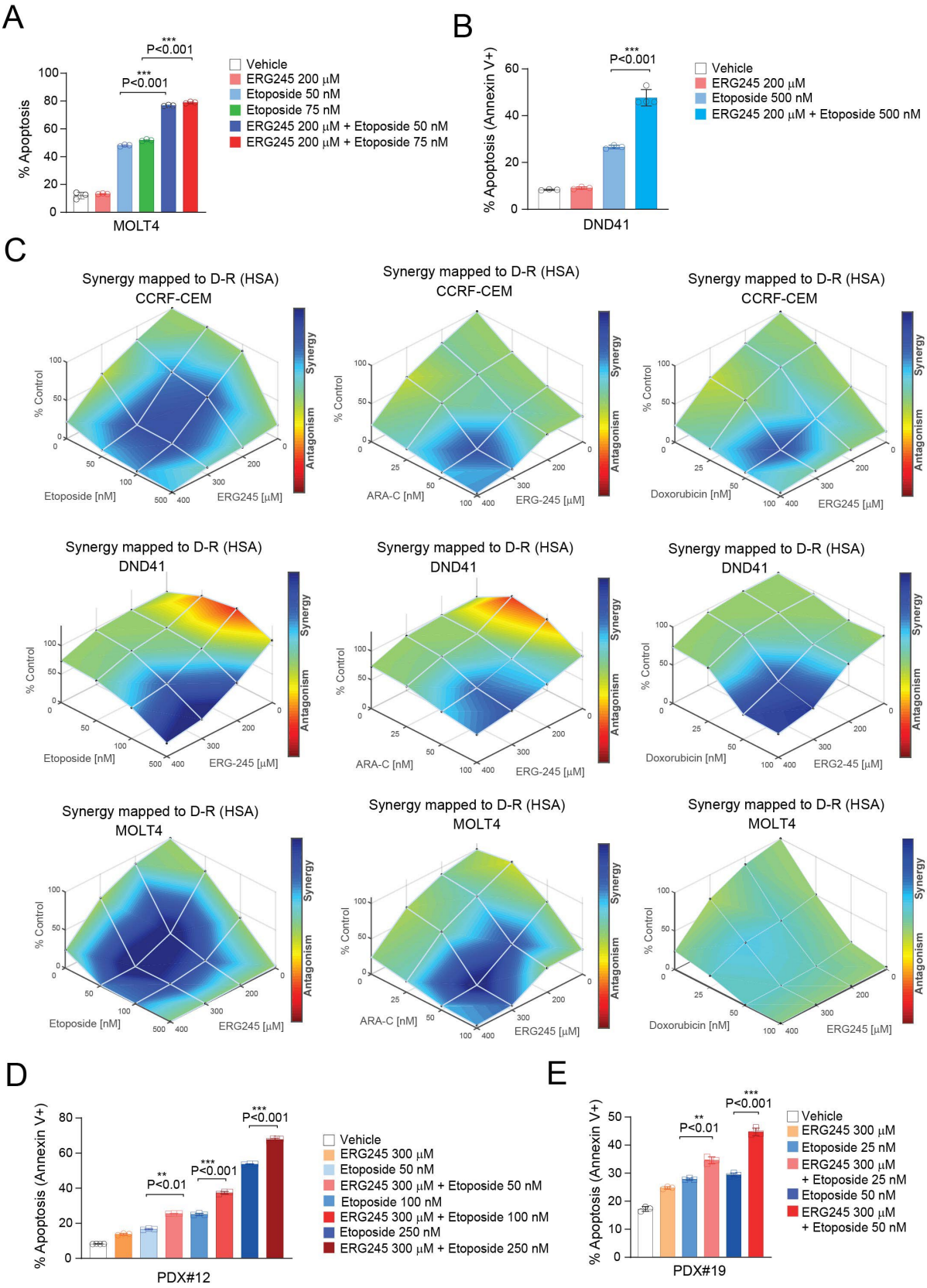


Figure S15. BCAT1 inhibition synergizes with numerous chemotherapeutic drugs to reduce cell viability. (A) Quantification of apoptosis in MOLT4 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245),

etoposide (Etop; 50-75 nM) or the combination (ERG245 + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. *** $P< 0.001$. (B) Quantification of apoptosis (Annexin V positive) in DND41 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245), etoposide (Etop) or the combination (ERG245 + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. *** $P< 0.001$. (C) CCRF-CEM, DND41 and MOLT4 T-ALL cells were incubated with different concentrations of etoposide (0- 500 nM, left panels), cytarabine/ara-C (0- 100 nM, middle panels) or doxorubicin (0- 100 nM, right panels) and ERG245 (0-400 μM) for 72h. After treatment, cell viability was assessed using a bioluminescent assay (Vialight plus). Analysis of combination efficacy and synergy for chemotherapeutic drugs (etoposide, ara-C and doxorubicin) and the BCAT inhibitor ERG245 was done using the HSA model with Combenefit software. (D) Quantification of apoptosis (Annexin V positive) in PDX#12 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245; 300 μM), etoposide (Etop: 50, 100, 250 nM) or the combination (ERG245 + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. ** $P< 0.01$, *** $P< 0.001$. (E) Quantification of apoptosis (Annexin V positive) in PDX#19 T-ALL cells treated with vehicle (DMSO), BCAT inhibitor (ERG245; 300 μM), etoposide (Etop: 25, 50 nM) or the combination (ERG245 + Etop) for 48h. Significance was calculated using an unpaired two-tailed t-test. ** $P< 0.01$, *** $P< 0.001$.

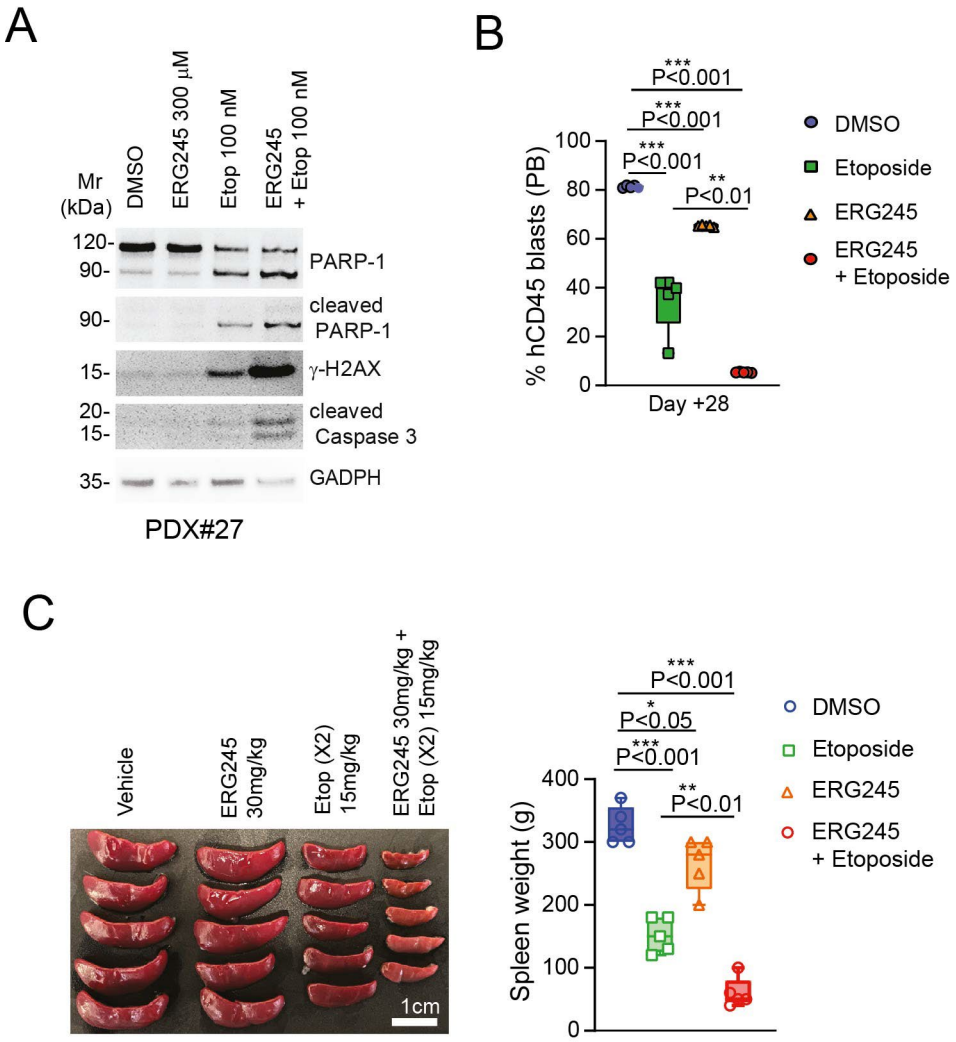


Figure S16. BCAT1 inhibition synergizes with etoposide to reduce viability. (A) Western blot analysis of PARP-1 (total or cleaved PARP-1), phosphorylated γH2AX and cleaved caspase 3 in PDX#27 cells treated for 48h with DMSO (vehicle), ERG245 (300 µM), etoposide (Etop; 100 nM) or ERG245 + Etop. GADPH was used as protein loading control. (B) Quantitative analysis of tumor burden in NSG mice xenografted with PDX#27-luc and treated with vehicle (DMSO), BCAT1 inhibitor (ERG245), etoposide (Etop) or the combination (ERG245+Etop), estimated by analyzing human CD45 expression in the blood (PB) at sacrifice. Significance was calculated using an unpaired two-tailed t-test. ***P*< 0.01, *** *P*< 0.001. (C) Representative images of spleens (left) and analysis of spleen weights (right) in PDX#27-luc xenografted mice at the end of treatment in NSG mice xenografted with PDX#27-luc and treated with vehicle (DMSO), BCAT1 inhibitor (ERG245), etoposide (Etop) or the combination (ERG245+Etop). Significance was calculated using an unpaired two-tailed t-test. **P*< 0.05, ***P*< 0.01, *** *P*< 0.001.

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