Long-term in vitro expansion ensures increased yield of central memory T cells as perspective for manufacturing challenges
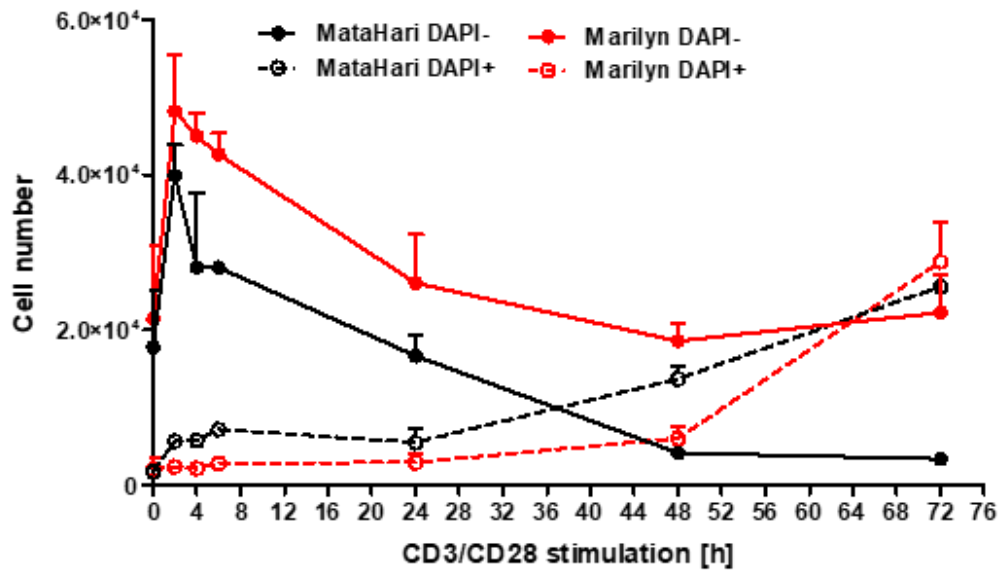
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Supplementary Material

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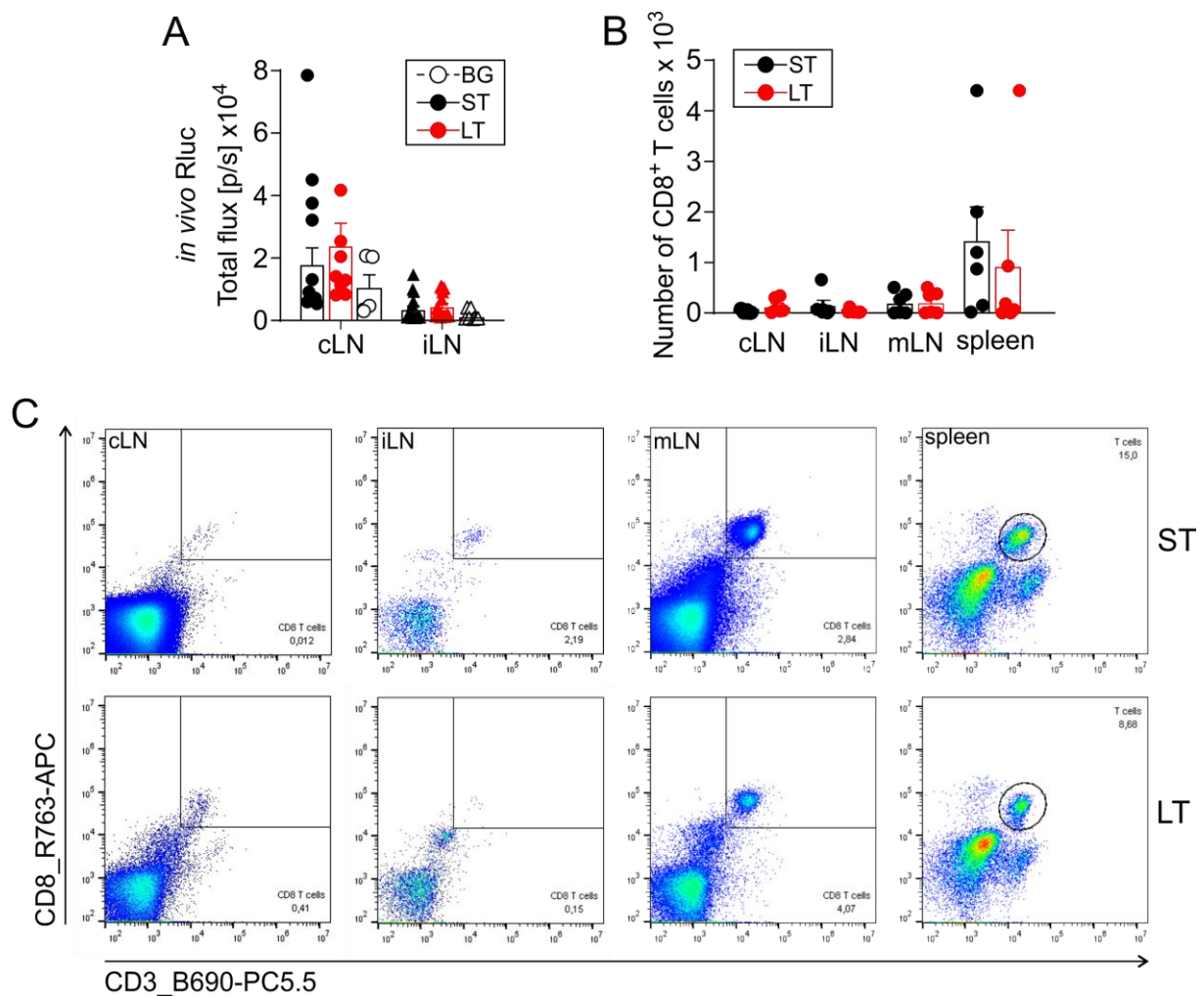- Supplementary Figures
- Supplementary Tables

Supplemental Figure 1. Activation of HY-TCR transgenic T cells. Absolute cell numbers (y-axis) are depicted upon anti-CD3/anti-CD28 stimulation over time (x-axis). For differentiation of live and dead/apoptotic cells, the DAPI staining solution was used. Numbers of DAPI positive cells were significantly increased by 72 hours after stimulation.
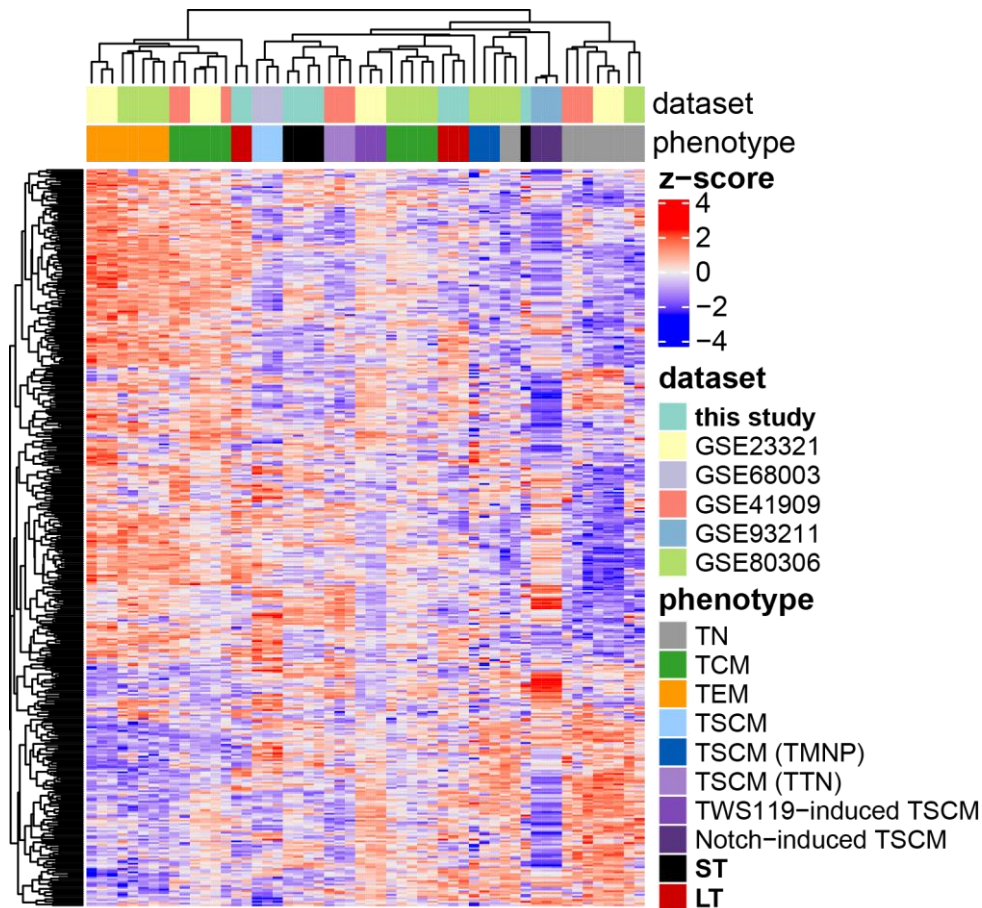
Supplemental Figure 2. Hierarchical clustering of ST and LT CD8^{+}Tcm, IL-7/IL-15-generated Tscm cells (TTN[6], GSE41909), naturally occurring CD8+ T cell subsets (TN, TEM, TCM, TSCM[11, 20, 34, 52], GSE23321), TWS119-enriched Tscm (TSCM[13], GSE68003) and Notch-induced Tscm (iTSCM[12], GSE93211), memory T cells with naïve phenotype (TMNP[23], GSE80306) based on 852 genes described by Gattinoni et al. from which 427 genes were expressed in all datasets. Each column represents a sample and each row a gene. Hierarchical clustering of ST and LT expanded Tcm, naturally occurring CD4^{+} T cell subsets ([24], GSE61697) and Notch-induced Tscm 12 based on 447 of the Gattinoni et al. genes that are expressed in all datasets. Each column represents a sample and each row a gene.

Supplemental Figure 3. Preserved Engraftment in RagKO recipients

(A) Mean ± SEM of Renilla luciferase flux values in cervical (cLN) and inguinal (iLN) one month after transfer of ST and LT T cells. BG=background (B) Number of CD8^{+} T cell quantified by flow cytometry, *ex* vivo, in cLN, iLN, mesenteric lymph nodes (mLN) and spleen one month after transfer. The bar diagram shows mean data ± SEM of total T cell numbers. (C) Representative flow cytometry plot of CD8^{+} isolated from cLN, iLN, mLN and spleen six months after transfer. The top row shows dot plots for the ST and the bottom row for the LT group, respectively. All data are representative of 2 independent experiments with n = 6-8 mice/group.
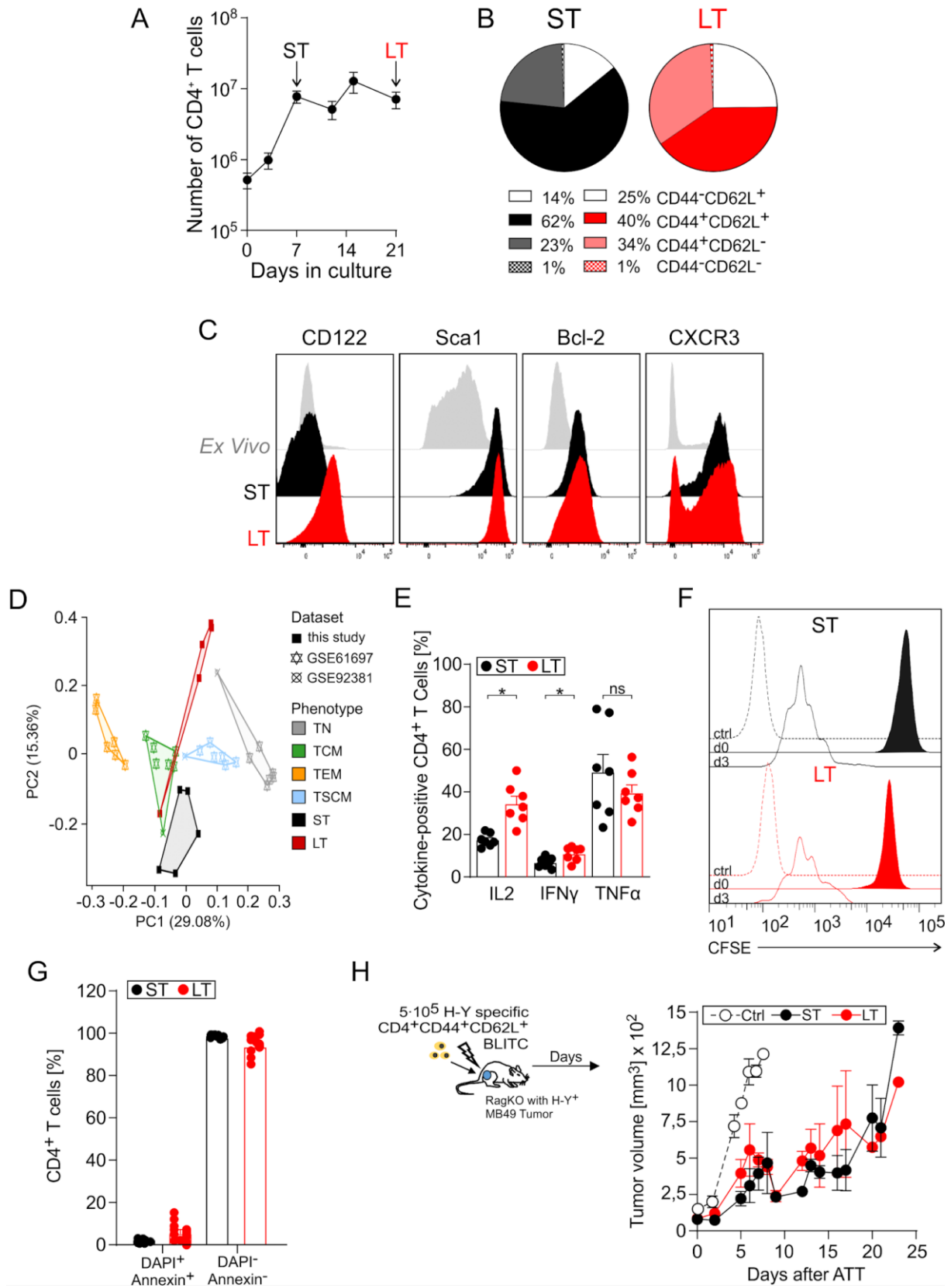
Supplemental Figure 4. *In vitro* expanded CD4+ T cells possesses stem-cell like and preserved functional properties

Polyclonal murine CD3$^+$ T cells isolated from C57BL/6 mice, activated via anti-CD3/CD28 antibodies (Abs) and IL-2 for 72 hours and further cultured with IL-7/IL-15 for 4 (ST) or 18 (LT) days. (A) Cell growth over the time of CD4$^+$ T cells identified through flow cytometry. The line corresponds to the mean values ± SEM of 5-7 independent experiments with n=5-9 mice. (B) Distribution of CD4$^+$ T cell subpopulations, defined by CD44 and CD62L markers after ST and LT culture. Data were generated in 5-7 independent experiments with n = 5-9 mice. (C) Analysis of CD122, Sca-1, Bcl-2 and CXCR3 expression by flow cytometry, in CD4$^+$ Tcm subset after ST and LT culture and in comparison to *ex vivo* CD4$^+$ T cells. Each expression pick is representative of 3 independent experiments with n = 3 mice. (D) Principal component analysis (PCA) of ST and LT expanded Tcm, naturally occurring CD4$^+$ T cell subsets ([24] GSE61697) and Notch-induced Tscm ([12] GSE92381) based on 447 of the Gattinoni et al. [11, 20, 34, 52] genes that are expressed in all datasets. Each dot represents a sample. (E) Flow cytometry expression profile analysis, of IL-2, IFNγ and TNFα cytokines in ST and LT CD4$^+$ T cells stimulated with anti-CD3/CD28 Abs. Bars show mean frequencies ± SEM. *p < 0.05, paired *t*-test. (F) Cell proliferation of ST and LT CD4$^+$ T after stimulation for 24h with anti-CD3/CD28 Abs and after 3 days of culture. Cell proliferation was assessed by using the Carboxyfluorescein Diacetate Succinimidyl Ester (CFSE). Signal intensity of CFSE was detected through flow cytometry. Colored pick corresponds to day 0, the line to day 4 and the dot line correspond to control (ctrl) unstained cells. Pick are representative of two independent experiments, with n=2 mice. Data mean MFI ± SD for ST-d4 = 1067,5 ± 343,6 and for LT-d4 = 597,3 ± 343,6 (G) Flow cytometry analysis of DAPI and Annexin expression in cells stimulated with anti-CD3/CD28 Abs and 3 days culture. The bars show mean frequencies ± SEM of apoptotic and/or dead cells (Annexin$^+$ and/or DAPI$^+$) and living cells (Annexin$^-$DAPI$^-$) for two independent experiments, with n=2 mice. (H) Left, Scheme for T cell transfer into MB49-tumor bearing female RagKO mice. Right, MB49 tumor growth kinetics after transfer of ST and LT cultured CD4$^+$ cells. Data are displayed by line diagram, mean ± SEM and are generated in two independent experiments with n = 3 mice per group.

Supplemental Figure 5. Hierarchical clustering of ST and LT CD4^{+} Tcm, Hierarchical clustering of ST and LT expanded Tcm, naturally occurring CD4^{+} T cell subsets ([24] GSE61697) and Notch-induced Tscm ([12] GSE92381) based on 447 of the Gattinoni et al. genes that are expressed in all datasets. Each column represents a sample and each row a gene.
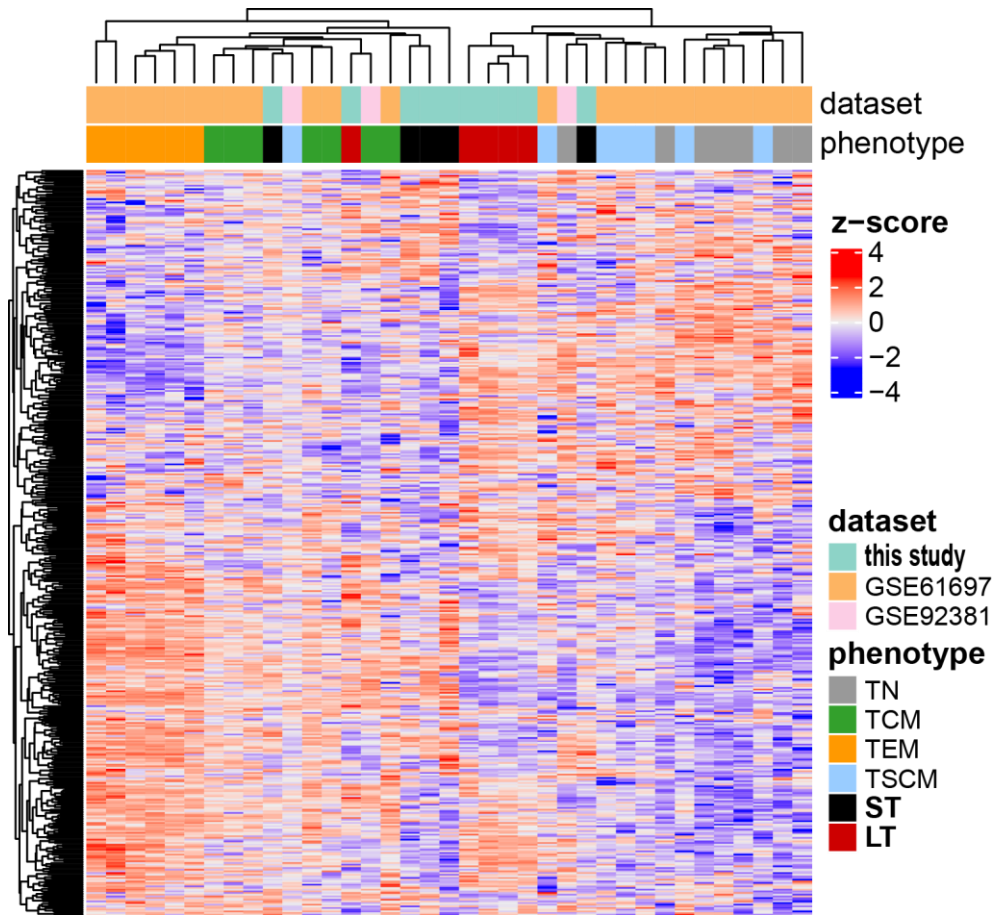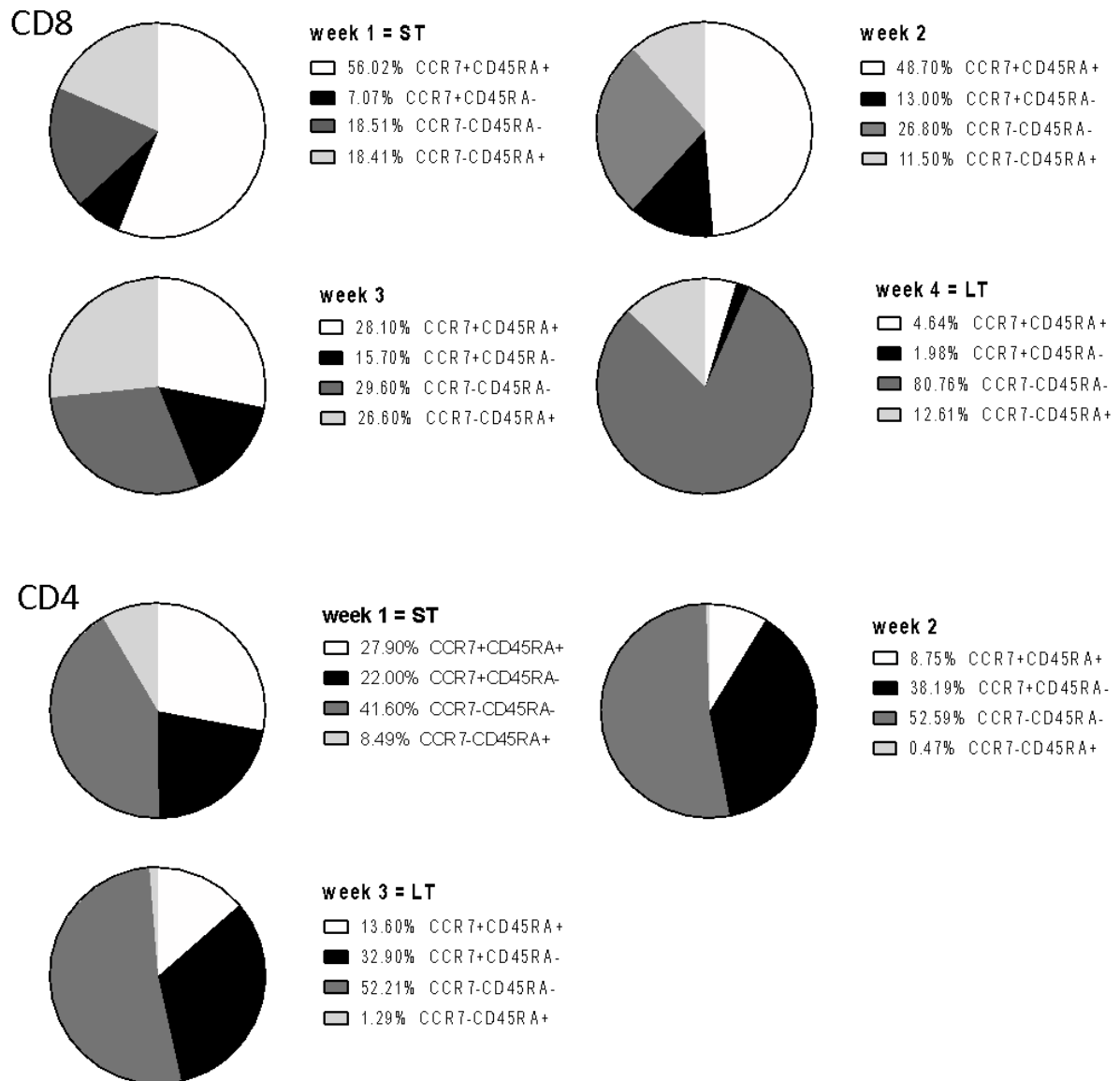
CD8

week 1 = S T
- 56.02% CCR7+CD45RA+
- 7.07% CCR7+CD45RA-
- 18.51% CCR7-CD45RA-
- 18.41% CCR7-CD45RA+

week 2
- 48.70% CCR7+CD45RA+
- 13.00% CCR7+CD45RA-
- 26.80% CCR7-CD45RA-
- 11.50% CCR7-CD45RA+

week 3
- 28.10% CCR7+CD45RA+
- 15.70% CCR7+CD45RA-
- 29.60% CCR7-CD45RA-
- 26.60% CCR7-CD45RA+

week 4 = LT
- 4.64% CCR7+CD45RA+
- 1.98% CCR7+CD45RA-
- 80.76% CCR7-CD45RA-
- 12.61% CCR7-CD45RA+

CD4

week 1 = S T
- 27.90% CCR7+CD45RA+
- 22.00% CCR7+CD45RA-
- 41.60% CCR7-CD45RA-
- 8.49% CCR7-CD45RA+

week 2
- 8.75% CCR7+CD45RA+
- 38.19% CCR7+CD45RA-
- 52.59% CCR7-CD45RA-
- 0.47% CCR7-CD45RA+

week 3 = LT
- 13.60% CCR7+CD45RA+
- 32.90% CCR7+CD45RA-
- 52.21% CCR7-CD45RA-
- 1.29% CCR7-CD45RA+

Supplemental Figure 6. Subset distribution of human T cells

Distribution of CD8^{+} and CD4^{+} T cell subpopulations analyzed by flow cytometry after staining with CCR7 and CD45RA antibodies.
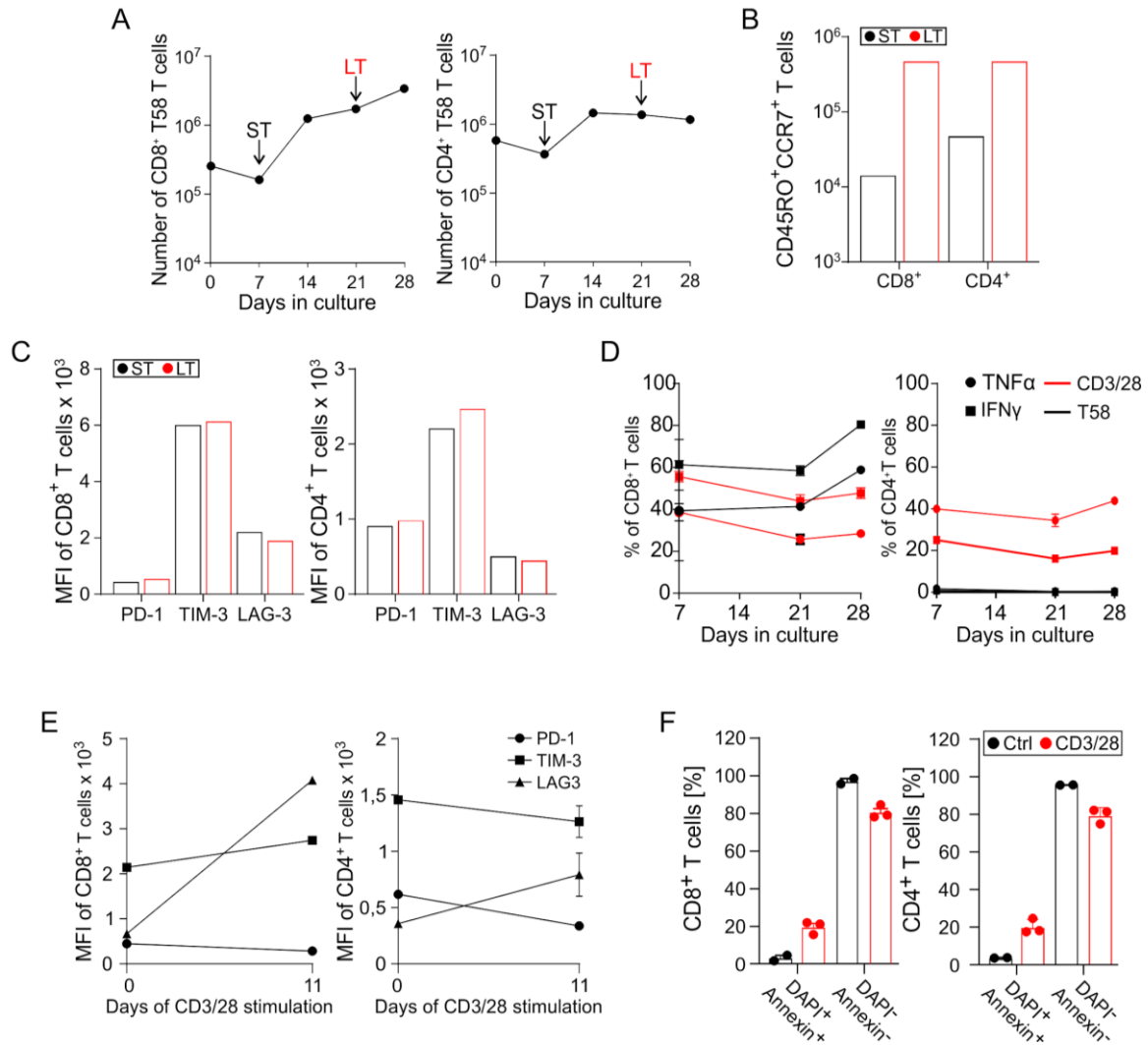
Supplemental Figure 7. Long-term expansion of T cells transduces with the tyrosinase-specific TCR (T58).

(A) Cell culture of human CD3$^+$ T cells isolated from healthy donors after transduction with a tyrosinase-specific TCR-T58 (T58) in a short-term and long-term culture setting. Proportion of CD8$^+$/CD4$^+$ subtype were identified through flow cytometry. Line diagram are representative of one single transduction experiment. (B) Distribution of CD8$^+$/CD4$^+$ T cell subpopulation, defined through flow cytometry by staining with CD45RO and CCR7 antibodies. (C) Mean fluorescence intensity (MFI) calculated through flow cytometry of inhibitory T cell receptors (TIRs) during ST and LT culture. (D) Cytokine production after 4h stimulation with anti-CD3/CD28 Abs and T58 specific peptide of CD8$^+$ and CD4$^+$. Analysis was performed through flow cytometry at day 7, 21 and 28 of culture. (E), (F) Flow cytometry expression profile analysis of TIRs, DAPI and Annexin in ST and LT transduced CD8$^+$ and CD4$^+$ after of 11 days of stimulation with anti-CD3/CD28 Abs. Line diagrams and bars are mean values ± SEM of triplicate.
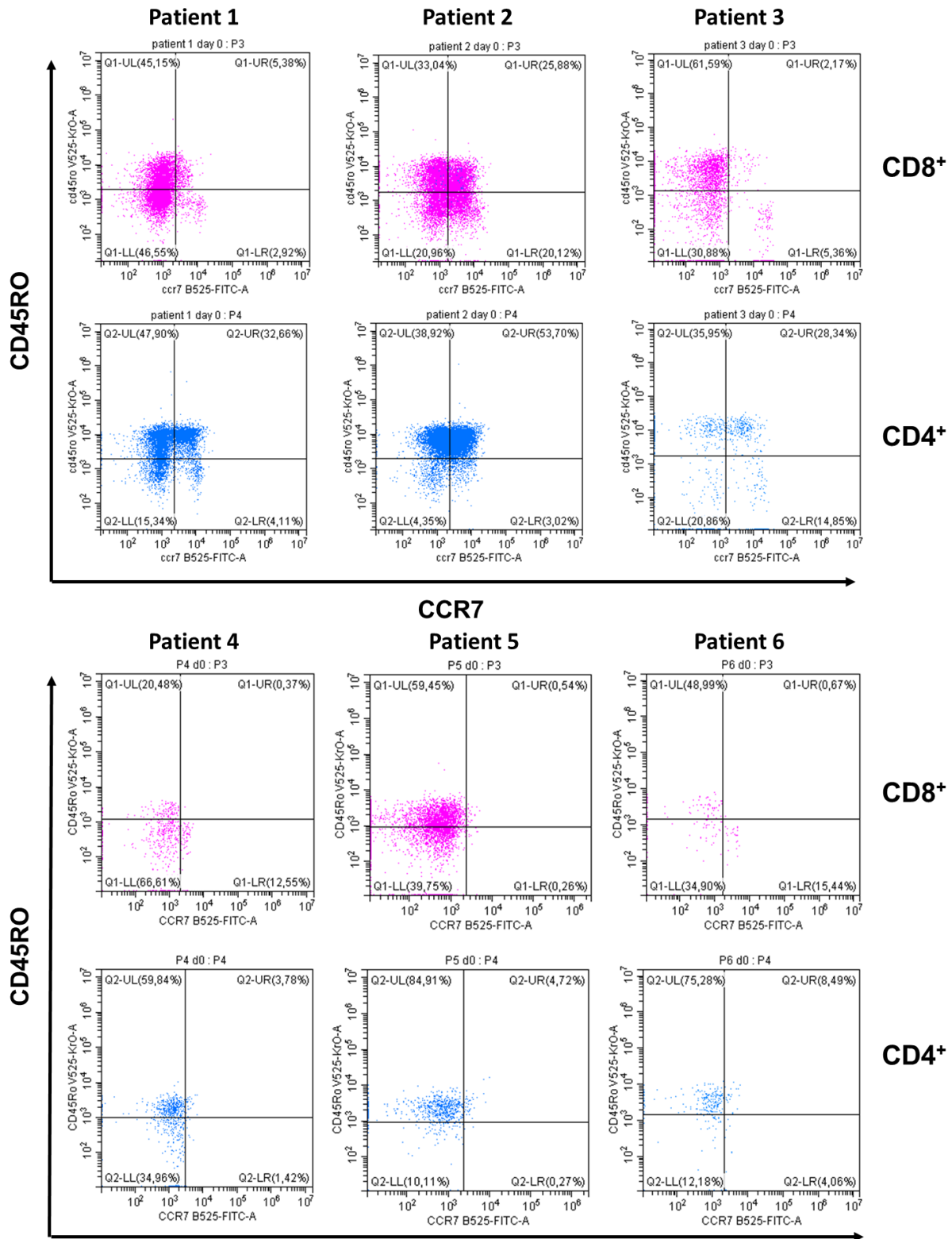
Supplemental Figure 8. CD45RO and CCR7 distribution in DLBCL patients

Representative flow cytometry plot of T cell subpopulation from 6 DLBCL patients by expression analysis of CD45RO and CCR7 for CD8$^+$ and CD4$^+$ T.

Supplementary Tables

Supplemental Table 1. List of mice

Marilyn-BLITC	Marilyn-TCR$^{+/+}$Rag1$^{-/-}$NFAT-CBR$^{+/+}$Rluc$^{+/+}$	Donor
albino B6	C57BL/6(Cg)-Tyrc-2J	Recipient
albino RagKO	B6.129S6-Rag2tm1Fwa N12-Tyrc-2J	Recipient

Supplemental Table 2. List of antibodies

anti-mouse CD3e	145-2C11	BioLegend
anti-mouse CD4	RM4-5	BioLegend
anti-mouse CD8a	53-6.7	BioLegend
anti-mouse CD19	6D5	BioLegend
anti-mouse/human CD44	IM7	BioLegend
anti-mouse CD62L	MEL-14	BioLegend
anti-mouse CD122	TM-BETA1	BD Biosciences
anti-mouse CD183 (CXCR3)	CXCR3-173	BioLegend
anti-mouse CD223 (LAG-3)	C9B7W	BioLegend
anti-mouse CD279 (PD-1)	HA2-7B1	BioLegend
anti-mouse CD366 (TIM-3)	RMT3-23	BioLegend
anti-mouse Bcl-2	BCL/10C4	BD Biosciences
anti-mouse IFN-γ	XMG1.2	BioLegend
anti-mouse IL-2	JES6-5H4	BioLegend
anti-mouse IL-10	JES5-16E3	BioLegend
anti-mouse Ly-6A/E (Sca-1)	E13-161.7	BD Biosciences
anti-mouse TNF-α	MP6-XT22	BioLegend
anti-human CD3e	UCHT1	BioLegend
anti-human CD8a	RPA-T8	BioLegend
anti-human CD4	RPA-T4	BioLegend
anti-human CD45RO	UCHL1	BioLegend
and anti-human IL-2	MQ1-17H12	BioLegend
anti-human CD223 (LAG-3)	REA351	Miltenyi Biotec
anti-human CD279 (PD-1)	PD1.3.1.3	Miltenyi Biotec
anti-human CD366 (TIM-3)	F38-2E2	Miltenyi Biotec
anti-human IFN-γ	45-15	Miltenyi Biotec
anti-human TNF-α	cA2	Miltenyi Biotec
anti-human CCR7	FAB197F-100	R&D Systems
DAPI (#D1306)		Thermo Fisher Scientific
Annexin V-APC (#640920)		BioLegend
Annexin V Binding Buffer (#422201)		BioLegend

Supplemental Table 3. List of top-significant genes for each GO Term

regulation of inflammatory response	Ptger3, Nlrp3, Nov, Nt5e, Lyn, Anxa1, Nr1d2, Rora, Acp5, Pdcd4, Shpk, Clock, Rps19
negative regulation of cell differentiation	Fat3, Tmem176a, Tmem176b, Trpc6, Olfm1, Cdkn2b, Ptger3, Nov, Cdkn2a, Pilrb1, Tnfrsf23, Lyn, Zhx2, Anxa1, Tnfrsf26, Rora, Trio, Axin2, Bmpr1a, Pdcd4, Tob1, Sorl1, Tnfrsf22
negative regulation of response to stimulus	Thbs1, Pid1, Dlg5, Dusp3, Adgrg3, Ptger3, Nlrp3, Camk2n1, Itga1, Nov, Nt5e, Nr1d1, Padi2, Tnfrsf23, Cdh1, Lyn, Camk2b, Nedd4, Anxa1, Prkcz, Rora, Gsto1, Acp5, Prr5l, Meis3, Axin2, Dand5, Pdcd4, Tob1, Pea15a, Sorl1, Tnfrsf22, Clock, Vps13c, Eya2, Ar, Rps19
positive regulation of biological process	Kirrel, Pgr, Gcnt2, Thbs1, Pid1, Trpc6, Dlg5, Pdlim4, Dusp3, Cdkn2b, Rab27b, Ptger3, Nlrp3, Camk2n1, Acvr2a, Itga1, Nov, Enpp2, Shank1, Naip5, Nr1d1, Fam83h, Btc, Cdkn2a, Alox8, Dok7, Yes1, Padi2, Sorbs3, Cdh1, Rxra, L1cam, Lyn, Camk2b, Plp1, Prr5, S100a4, Maml3, Myo3b, Fasl, Nedd4, Rwdd3, Anxa1, Dock4, Naip2, Impact, Klrb1c, Lrrk1, Nr1d2, Lpar6
enzyme linked receptor protein signaling pathway	Gcnt2, Thbs1, Pid1, Cdkn2b, Cnpy1, Acvr2a, Itga1, Nov, Btc, Yes1, Pilrb1, Fut8, Lyn, Fasl, Nedd4, Btbd11, Prkcz, Dand5, Zfp950, Bmpr1a, Pdcd4, Tob1, Txk, Txnip, Ar
immune system process	Thbs1, Tmem176a, Tmem176b, Dlg5, Dusp3, Adgrg3, Cdkn2b, Ptger3, Nlrp3, Lilrb4a, Acvr2a, Itga1, Nov, Enpp2, Naip5, Nr1d1, Podxl, Cdkn2a, Yes1, Padi2, Gab3, Pilrb1, Tnfrsf23, Cd7, Sarm1, Ston2, Lyn, Fasl, Nedd4, Anxa1, Naip2, Klrb1c, Lrrk1, Chrnb2, Il18r1, Mcoln2, Prkcz, Tnfrsf26, Hcst, Rora, Il11ra1, Zfp950, Bmpr1a, Hoxb4, Shpk, Txk, Fv1, Prkx, Tnfrsf22, Rps19
mitotic sister chromatid cohesion	Cdc20, Cdca5, Sgo1, Dscc1, Haspin, Smc5
establishment of spindle localization	Spry1, Sapcd2, Cenpa, Spdl1, Ndc80, Nusap1, Spag5
positive regulation of double-strand break repair	Foxm1, Blm, Timeless, Fancb, Mrnip
positive regulation of catalytic activity	Cd81, Ajuba, Ccnb1, Plk1, Cdc20, Stil, Cenpe, Mastl, Aurkb, Plxnb1, Gprc5b, Nek2, Cks1b, Ect2, Pdgfb, Serinc5, Hmgb2, Dhfr, Nab2, Dscc1, Gsn, Vav2, Lmnb1, Chtf18, Rfc3, Clspn, Cdc6, Cd74, Usp6nl, Rgs1, Ccdc88a, Plek, Ezh2, Rfc5, Trib1, Cks2, Map3k9, Rfc4, Ncf1, Wdr35, Ube2s, Pcna, Pml, Mrnip, Fas, Rgcc, Dnajc9, Stk39, Tbc1d7, Msh6
establishment of spindle orientation	Spry1, Sapcd2, Cenpa, Spdl1, Ndc80, Spag5
positive regulation of cell proliferation	Cd81, Atf3, Cd86, Nr4a1, Smo, Ccnb1, Marcksl1, Rtkn2, Sapcd2, Cdc20, Foxm1, C330027C09Rik, Foxp3, Cdk1, Pdgfb, Aspm, Hmgb2, Prc1, Tnfrsf4, Blm, Recql4, Tet1, Cdc6, Atad5, Cd74, Kif20b, Nr4a3, Cdk2, Slamf1, Hmgcr, Tipin, Hpse, Rad51b, Nlgn2, Lif, Cdc7, E2f1, Pml, Skp2, Rnaseh2b, Ctc1, Hif1a, Ada, Mvd, Adk, Cd6, Ptpn6, Fxn, Anp32b, Ppp1r16b

Supplemental Table 4. List of altered genes in LT CD8+ and CD4+ T cells

CD4_up	CD8_up	CD4_down	CD8_down	both_up	both_down
1190002N15Rik	1110034G24Rik	1700067K01Rik	1500009L16Rik	1700029J07Rik	2410004P03Rik
1700029J07Rik	1700001C19Rik	2410004P03Rik	1700012D01Rik	1810010D01Rik	2610524H06Rik
1810010D01Rik	1700025G04Rik	2610524H06Rik	1700066B19Rik	1810024B03Rik	2700081O15Rik
1810011H11Rik	1700029J07Rik	2700081O15Rik	1810010H24Rik	5730409E04Rik	4932438H23Rik
1810024B03Rik	1810010D01Rik	2900026A02Rik	1810037I17Rik	9330151L19Rik	A930011G23Rik
3830408C21Rik	1810024B03Rik	4932438H23Rik	1810055G02Rik	Abhd14b	Aacs
5730409E04Rik	2010005H15Rik	A930011G23Rik	2410004P03Rik	Acad10	Aars
9330151L19Rik	2010300C02Rik	Aacs	2610318N02Rik	Acad12	Abhd17c
Abca5	2210416O15Rik	Aars	2610524H06Rik	Acp5	Acat2
Abhd12b	2300009A05Rik	Abhd17c	2700049A03Rik	Acpp	Acsl3
Abhd14a	2510009E07Rik	Acat2	2700081O15Rik	Acvr2a	Adk
Abhd14b	2810021J22Rik	Acsl3	4930404N11Rik	Adat1	Aida
Abhd15	2810474O19Rik	Adamts3	4930503L19Rik	Adgre5	Ajuba
Ablim2	4430402I18Rik	Adk	4930579G24Rik	Adgrg3	Akap12
Acad10	4930548H24Rik	Adora2b	4932438H23Rik	Ago3	Aldh2
Acad12	4932438A13Rik	Agpat4	6430531B16Rik	AI429214	Ankrd9
Acp5	4932443I19Rik	Aida	6720489N17Rik	AI661453	Anp32b
Acpp	5730409E04Rik	Aif1	9530077C05Rik	Alox5	Apobec2
Acsf2	6430550D23Rik	Ajuba	A730008H23Rik	Amigo1	Armcx6
Acss2	9130008F23Rik	Ak6	A830010M20Rik	Ank	Atad5
Acvr2a	9330151L19Rik	Akap12	A930011G23Rik	Ank1	Atcay
Adat1	A430078G23Rik	Akr1c18	Aacs	Arap2	Atrnl1
Adgre5	A630001G21Rik	Alcam	Aars	Arl4c	Bard1
Adgrg3	AA467197	Aldh2	Abca3	AW554918	Bcat1
Agbl3	Abcb1a	Ankrd9	Abcg2	Axin2	Bcl3
Ago3	Abcb4	Anp32b	Abhd10	Bach1	Bcl9
Agpat2	Abcc10	Apcdd1	Abhd17c	BC049715	Bclaf3
AI429214	Abcc5	Apobec2	Abi2	Bend6	Bhlhb9
AI661453	Abcg1	Arhgef10	Ablim2	Btbd11	Blm
Aldh6a1	Abhd14b	Armcx1	Acadl	C030006K11Rik	Cand2
Alox5	Abi3	Armcx3	Acat2	C87436	Capn3
Amigo1	Abi3bp	Armcx6	Ace	Camk2n1	Casp3
Amz1	Ablim3	Atad5	Acsl3	Car12	Cbx2
Ank	Abr	Atcay	Actn2	Car7	Ccdc141
Ank1	Acad10	Atp9a	Ada	Ccdc136	Ccdc50
Aoc2	Acad12	Atrnl1	Adamtsl5	Ccdc38	Ccne1
Appl2	Acp5	B4galt5	Adap1	Cd200r4	Ccne2

Arap2	Acpp	Bambi	Adarb1	Cdh1	Ccrl2
Arhgap23	Acrbp	Bard1	Adcy6	Cdk14	Cd200
Arl4c	Acvr2a	Basp1	Adgrl1	Cdkn2b	Cd5
Asph	Adam1a	Batf	Adk	Chrnb2	Cd6
Atrn	Adam4	Bcas1	Afap1	Cipc	Cd81
AW554918	Adat1	Bcat1	Agbl2	Cnbd2	Cd86
Axin2	Adcy7	Bcl2a1b	Agfg2	Cnpy1	Cdc25a
B3galnt1	Adgre5	Bcl3	Ahcy	Cntnap1	Cdc42ep4
B4galnt4	Adgrg3	Bcl9	Aida	Col20a1	Cdc7
Bach1	Adgrg5	Bclaf3	Aig1	Coq8a	Cdca4
Bbof1	Adrb1	Bhlhb9	Aipl1	Crebl2	Cdh24
BC005561	AF529169	Bicdl1	Ajuba	Ctnnd2	Cdk2
BC048403	Agap1	Blm	Ak1	Cux1	Cdt1
BC049715	Ago3	Cand2	Ak2	Cxcr6	Cenpa
Bend6	Ago4	Capn3	Akap12	Cyb5d2	Cep72
Bpifb4	Ahnak	Car5b	Akip1	Cyb5rl	Cfap77
Btbd11	Ahrr	Card9	Alad	Cyp4f13	Chchd10
C030006K11Rik	AI429214	Casp3	Aldh1l2	CYTB	Chrm4
C2	AI661453	Casp8	Aldh2	Diaph2	Clic4
C530008M17Rik	Aifm2	Cbarp	Aldh5a1	Disc1	Cnn3
C87436	Akap8l	Cblb	Aldh7a1	Dlg5	Coro2a
Camk2n1	Akt1s1	Cbx2	Alg6	Dmrta1	Cox6b2
Car12	Alkbh4	Cbx6	Alg8	Dnah11	Csrp1
Car7	Alox5	Ccdc141	Alms1	Dnajc28	Ctla4
Ccdc136	Alox8	Ccdc28b	Alpk1	Dnhd1	Ctnnbip1
Ccdc38	Amigo1	Ccdc50	Alpk2	Doc2g	Cul7
Ccr2	Ank	Ccne1	Alyref	Dok7	Dbf4
Cd200r1	Ank1	Ccne2	Anapc15	Dse	Dbi
Cd200r4	Ankrd23	Ccrl2	Anapc5	Dtx4	Dclk2
Cd7	Anks3	Cd200	Angptl2	Dusp23	Dek
Cd93	Anks6	Cd248	Angptl6	Dusp3	Dhcr7
Cdh1	Antxr2	Cd24a	Ankle1	Dyrk4	Dhfr
Cdk14	Anxa1	Cd5	Ankrd13b	Echdc2	Dlg3
Cdk18	Ap3m2	Cd6	Ankrd29	Eml6	Dna2
Cdkn2b	Ap5z1	Cd81	Ankrd9	Enpp2	Dnajc9
Celf4	Aplp2	Cd86	Anln	Enpp4	Dnmt1
Chil5	Apobr	Cdc14a	Anp32b	Enpp5	Dnmt3a
Chrnb2	Apol10b	Cdc25a	Anp32e	Evi5	Dpysl2
Cipc	Apol7b	Cdc42ep4	Anxa2	Fam120c	Drp2
Cldn12	Apol7e	Cdc7	Ap1s3	Fam83h	Dsn1

Clec11a	Aqp9	Cdca4	Ap3s1	Fat3	Dusp4
Clstn1	Ar	Cdcp1	Apip	Fbxl2	E2f2
Cnbd2	Araf	Cdh24	Aplf	Fndc10	Eme1
Cnpy1	Arap2	Cdh5	Apln	Frg2f1	Enkd1
Cntnap1	Arhgap25	Cdk2	Apobec2	Frmd4a	Eno2
Col20a1	Arhgap4	Cdkn2d	Apold1	Fut8	Epb41l2
Comp	Arhgap45	Cdt1	Apon	Fv1	Ephx1
Coq8a	Arhgap6	Cenpa	Apoo	Gab3	Ercc6l
Crebl2	Arhgef18	Cep72	App	Gcm2	Ets2
Creg1	Arhgef4	Cfap77	Arf2	Gcnt2	Extl3
Ctnnd2	Arl4a	Chchd10	Arfgef3	Ggnbp1	Fabp5
Cux1	Arl4c	Chpt1	Arhgap11a	Gm1043	Fah
Cxcr6	Armc2	Chrm4	Arhgap19	Gm20219	Fanca
Cyb5d2	Armc7	Chst15	Arhgap29	Golm1	Fancb
Cyb5rl	Art2b	Chst2	Arhgap33	Gpr137b	Fancm
Cyp27b1	Asap2	Clec2i	Arhgef25	Gsto1	Fas
Cyp4f13	Asb13	Clic4	Arhgef39	Guca1b	Fbxo5
CYTB	Asb2	Cnn3	Arhgef40	Hcn3	Fdft1
Daglb	Ash1l	Coro2a	Arhgef9	Hcst	Fdps
Dapk2	Atf7	Cox6b2	Arl11	Herc1	Fen1
Dbndd2	Atg2a	Cradd	Arl6	Hist3h2a	Fkbp11
Dennd5a	Atn1	Csrp1	Arl6ip1	Hoxb4	Fut4
Dgkh	Atp6v0a1	Ctdspl	Arl6ip6	Hpgds	Fxn
Diaph2	Atp6v0c	Ctla4	Armcx6	Hsd17b11	Gamt
Disc1	Atp8a2	Ctnnbip1	Arntl2	Icam5	Gins1
Dlg5	AW146154	Cttn	Arrdc3	Ifitm10	Gins2
Dmrta1	AW549877	Cul7	Arsb	Impact	Gmnn
Dnah11	AW554918	Cxcl10	Arsg	Itga1	Gnb4
Dnajb4	Axin2	Dbf4	Art4	Kctd15	Gpld1
Dnajc28	B3galt2	Dbi	As3mt	Kirrel	Gstt1
Dnhd1	B3galt5	Dcakd	Asap3	Klra2	Gtf2ird1
Doc2g	B4galnt2	Dclk2	Asb16	Kmt2d	H2afv
Dok7	B4galt4	Ddx43	Asf1b	L1cam	Haus4
Dopey1	B4galt7	Dek	Asns	Large1	Hectd2
Dph1	B630019K06Rik	Dhcr7	Aspm	Lcn12	Hells
Dqx1	Bace2	Dhfr	Atad2	Ldlrad4	Helq
Dse	Bach1	Dlg3	Atad5	Leng8	Hif1a
Dtx4	Baiap3	Dna2	Atcay	Lilrb4a	Hist1h1a
Dusp23	Bbc3	Dnajc9	Atf3	Lpar6	Hist1h1d
Dusp3	Bbs9	Dnmt1	Atf4	Lpcat2	Hist1h2ab

Dyrk4	BC024978	Dnmt3a	Atf5	Lrrc24	Hist1h2ag
E2f5	BC025920	Dpysl2	Atl2	Man2a2	Hist1h2ak
Echdc2	BC029722	Drp2	Atp13a3	Maneal	Hist1h2bb
Eda2r	BC030336	Dsn1	Atp1b1	Mcoln2	Hist1h3e
Eml6	BC037034	Dtymk	Atp1b2	Mdn1	Hist1h3g
En2	BC049715	Dusp14	Atpif1	Meis3	Hist1h3i
Enpp2	Bckdhb	Dusp4	Atrnl1	Metap1d	Hist1h4b
Enpp4	Bcl2l11	E2f2	Aunip	Mettl27	Hist1h4f
Enpp5	Bcl6	Ebi3	Aurka	Mettl7a1	Hmgb2
Ermap	Bend6	Ecm1	Aurkb	Mthfsd	Hmgb3
Esrrb	Birc6	Efna4	Azin1	Myl10	Hmgcr
Evi5	Blcap	Egr3	Azin2	Myo18b	Hmgcs1
Exd1	Bmpr1a	Ehhadh	B230217C12Rik	Myo3b	Hmgn3
Fam120c	Borcs8	Eme1	B4galnt4	Naip2	Hmgn5
Fam129a	Brpf3	Enkd1	B4galt2	Naip5	Hnrnpd
Fam222a	Brwd1	Eno2	B9d1	Nbeal1	Hspa12a
Fam83h	Btbd11	Epb41l2	Baiap2	ND4	Hspa4l
Fat3	Btbd16	Epcam	Banf1	ND5	Idh2
Fbxl2	Btc	Ephb6	Bard1	Nedd4	Igf2bp3
Fgfbp3	Btg1	Ephx1	Batf3	Nedd4l	Igsf23
Fgfr1	Btg2	Ephx4	Baz2b	Nhsl2	Ildr1
Fndc10	C030006K11Rik	Ercc6l	Bbip1	Nipa1	Incenp
Frg2f1	C87436	Ets2	BC030867	Nlrp3	Insig1
Frmd4a	Cacng8	Extl3	BC035044	Nmnat3	Iqcb1
Fut8	Calcoco1	Fabp5	BC055324	Nov	Irf4
Fv1	Camk2b	Fah	Bcam	Nr1d1	Irf6
Gaa	Camk2n1	Fam111a	Bcar1	Nr1d2	Irf8
Gab3	Camkk1	Fam84a	Bcat1	Nr6a1	Itga5
Gadd45a	Camta2	Fanca	Bcl2l14	Nt5e	Itpka
Ganc	Car12	Fancb	Bcl3	Olfm1	Izumo1r
Gcm2	Car2	Fancm	Bcl6b	Olig3	Kdm8
Gcnt2	Car7	Fas	Bcl7c	Osgin1	Kifc1
Ggnbp1	Card6	Fbxo44	Bcl9	Ovgp1	Kifc5b
Glipr1	Cbx7	Fbxo5	Bclaf3	Padi2	Klc3
Gm1043	Ccdc136	Fdft1	Begain	Pard3	Klhl23
Gm14085	Ccdc17	Fdps	Bend4	Pclo	Kpna2
Gm20219	Ccdc171	Fen1	Bex1	Pctp	Lacc1
Gm29719	Ccdc38	Fgf2	Bex3	Pde1b	Lad1
Gm29721	Ccdc88c	Fgr	Bex6	Pdlim4	Lag3
Gm35315	Ccdc92	Fkbp11	Bhlhb9	Pfkfb2	Ldhb

Gm5481	Ccl5	Fut4	Birc5	Pgr	Lig1
Gm6109	Ccnd2	Fxn	Blm	Phf21b	Lin9
Gm6570	Ccpg1	Gamt	Blvrb	Pid1	Litaf
Gm7429	Ccr5	Gemin8	Bmp2k	Pigz	Lpcat1
Gm973	Cd200r4	Ggt7	Bmp7	Pkd1l3	Lrmp
Gm9958	Cd300lf	Ggta1	Bora	Plp1	Maged2
Golm1	Cd46	Gins1	Borcs7	Plxdc2	Magi3
Gpr137b	Cdc42bpb	Gins2	Brca1	Prkcz	Mansc1
Grasp	Cdc42ep3	Gm19463	Brca2	Prkd3	Map3k9
Gsto1	Cdh1	Gm20939	Bricd5	Prkx	Map7
Guca1b	Cdh13	Gm5148	Brip1	Prr5	Marcksl1
H2-Q10	Cdhr4	Gmnn	Brsk1	Prss16	Mast2
Hcn3	Cdk14	Gnb4	Bst1	Psd2	Mboat7
Hcst	Cdkl2	Gpc1	Btbd10	Ptger3	Mcm2
Heatr5a	Cdkn1b	Gpld1	Btbd8	Pvrig	Mcm3
Herc1	Cdkn2a	Gpr18	Bub1	Pyroxd2	Mcm4
Hist3h2a	Cdkn2b	Gpr83	Bub1b	Qtrt2	Mcm5
Hlcs	Cdnf	Gsn	Bub3	Rab20	Mcm6
Hoxb4	Cdo1	Gstt1	C1qtnf12	Rab27b	Mcm7
Hpgds	Cebpd	Gtf2ird1	C3	Rab6b	Mcu
Hsd17b11	Chd3	H2afv	C330027C09Rik	Reck	Mms22l
Icam5	Chic1	Haus4	Cacna1b	Rps19	Mnd1
Ids	Chpf2	Hectd2	Cacna1s	Rps21	Msh6
Ifitm1	Chrnb1	Hells	Cacnb3	Rps28	Msmo1
Ifitm10	Chrnb2	Helq	Calm2	Rrp12	Mtbp
Ifitm2	Chrne	Hemk1	Calm3	Rsad1	Mthfd2
Ifitm5	Cipc	Hif1a	Camk4	Rwdd3	Mvd
Igdcc4	Cited4	Hist1h1a	Cand2	Sarm1	Mxra8
Il1rl1	Clcf1	Hist1h1d	Capn3	Sbsn	Mybl2
Impact	Cldnd2	Hist1h2ab	Capn5	Sec31b	Mylpf
Ipo4	Clhc1	Hist1h2ag	Caprin2	Sept8	Nab2
Irgc1	Clic5	Hist1h2ai	Capsl	Setbp1	Nasp
Isca1	Cln3	Hist1h2ak	Car13	Sez6l2	Ncf1
Itga1	Clnk	Hist1h2bb	Carmil1	Sgsh	Ncs1
Itga2	Clock	Hist1h3e	Cars	Shpk	Ndc80
Jag2	Cmklr1	Hist1h3g	Casc1	Six3	Ndufa4
Kazald1	Cnbd2	Hist1h3i	Casp3	Slc25a27	Neu3
Kcna6	Cnpy1	Hist1h4b	Casp4	Slc25a53	Nmral1
Kcnh5	Cnr2	Hist1h4f	Casp7	Slc26a11	Noxred1
Kctd15	Cnrip1	Hivep3	Casp8ap2	Slc26a8	Nr4a1

Kif13a	Cntn1	Hmgb2	Cass4	Slc7a4	Nr4a3
Kif3a	Cntnap1	Hmgb3	Cbwd1	Sorbs3	Nrbp2
Kirrel	Col11a2	Hmgcr	Cbx2	Sorl1	Nrgn
Kit	Col20a1	Hmgcs1	Cbx3	Specc1	Nsd2
Klf12	Col6a2	Hmgn3	Cbx5	Speg	Nsdhl
Klra2	Col9a3	Hmgn5	Cby1	Stc2	Nsmce1
Klrb1c	Coq8a	Hnrnpd	Ccdc106	Ston2	Ntf5
Klrc1	Cpeb3	Hsf4	Ccdc114	Suco	Nup37
Kmt2d	Cpq	Hspa12a	Ccdc138	Sulf2	Nup62
L1cam	Crebl2	Hspa4l	Ccdc14	Sult4a1	Nyap1
Large1	Crebrf	Hspa5	Ccdc141	Susd4	Orc6
Lars2	Crisp1	Idh2	Ccdc18	Syt6	Pabpc1l
Lcn12	Csf2ra	Igf2bp3	Ccdc184	Taz	Pcgf5
Ldlrad4	Csnk1g1	Igsf23	Ccdc25	Tdrp	Pdcd1
Leng8	Ctnnd2	Ildr1	Ccdc34	Tfap2a	Pdgfb
Lilrb4a	Ctsf	Incenp	Ccdc40	Thbs1	Pdk3
Lpar6	Ctxn1	Insig1	Ccdc50	Tmem176a	Phactr2
Lpcat2	Cuedc1	Iqcb1	Ccdc77	Tmem176b	Phf19
Lrrc24	Cul9	Irf4	Ccdc85c	Tmem80	Pkib
Lrrc51	Cux1	Irf6	Ccdc88a	Tnfrsf22	Plcl1
Lrtm2	Cxcr3	Irf8	Ccdc90b	Tnfrsf23	Plek
Lyn	Cxcr6	Isg15	Ccna2	Tnfrsf26	Plekho1
Lyrm9	Cyb5d2	Itga5	Ccnb1	Tob1	Plk4
Man2a2	Cyb5rl	Itpka	Ccnb2	Tom1l1	Plpp1
Maneal	Cyp4f13	Izumo1r	Ccne1	Tpbgl	Plxnb1
Map4k5	Cyp4f16	Jaml	Ccne2	Tpgs2	Plxnd1
Matn1	CYTB	Kcnh2	Ccnf	Trim65	Pml
Mcoln2	D130040H23Rik	Kcnmb4	Ccnyl1	Trio	Pmvk
Mctp1	D3Ertd751e	Kdm2b	Ccp110	Trpc6	Pold3
Mdn1	D930048N14Rik	Kdm8	Ccr1	Ttll3	Pole2
Meis3	Dalrd3	Kifc1	Ccr4	Txnip	Ppp1r16b
Metap1d	Dand5	Kifc5b	Ccr8	Unc5a	Prim1
Mettl27	Dcdc2b	Klc3	Ccr9	Wdr95	Ptgfrn
Mettl7a1	Dcun1d4	Klhl23	Ccrl2	Yes1	Ptms
Mex3a	Ddx60	Kpna2	Ccsap	Zfp420	Ptpn6
Mfsd13b	Dennd1c	Lacc1	Cd101	Zfp493	Pxmp2
Mical2	Dennd2d	Lad1	Cd200	Zfp652	Rasgef1b
Mipol1	Dennd4c	Lag3	Cd22	Zfp661	Rbl1
Mocos	Dglucy	Lancl3	Cd4	Zfp950	Rcan3
Mrm1	Dhrs3	Lcat	Cd5	Zfp970	Rdh11

Mthfsd	Diaph2	Ldhb	Cd6	Zfp992	Recql4
Mturn	Dirc2	Lig1	Cd74	Zrsr1	Rfc2
Mtus1	Disc1	Lin9	Cd79b		Rfc3
Myl10	Dixdc1	Litaf	Cd80		Rfc5
Myo18b	Dlec1	Lmln	Cd81		Ripply3
Myo3b	Dlg5	Lpcat1	Cd83		Rnaseh2b
Myo6	Dlgap4	Lrmp	Cd86		Rnf168
N6amt1	Dmrta1	Lyl1	Cd9		Rnf208
Naip2	Dnah11	Maged2	Cdc20		Rpa2
Naip5	Dnajb14	Magi3	Cdc20b		Sass6
Nbeal1	Dnajb9	Mansc1	Cdc25a		Serinc5
Nckap1	Dnajc28	Map3k12	Cdc25b		Sfmbt2
ND2	Dnhd1	Map3k9	Cdc25c		Sh3rf1
ND4	Doc2g	Map7	Cdc27		Sik1
ND5	Dock4	Marcks	Cdc42ep4		Slamf1
Nedd4	Dok7	Marcksl1	Cdc45		Slc15a3
Nedd4l	Dpp7	Mast2	Cdc6		Slc1a4
Nhsl2	Dsc2	Mboat7	Cdc7		Slc25a13
Nid2	Dscam	Mcm2	Cdca2		Slc31a1
Nipa1	Dse	Mcm3	Cdca3		Slc43a1
Nipal1	Dsg2	Mcm4	Cdca4		Slc43a3
Nlrp3	Dsp	Mcm5	Cdca5		Slc4a11
Nmnat3	Dst	Mcm6	Cdca7		Slc9b2
Nmrk1	Dtx1	Mcm7	Cdca8		Slfn3
Nov	Dtx4	Mcu	Cdh17		Smc5
Npc1l1	Dus3l	Mcub	Cdh24		Spock2
Nr1d1	Dusp23	Mical1	Cdk1		Spred1
Nr1d2	Dusp28	Mmd	Cdk2		Sqle
Nr2c1	Dusp3	Mms22l	Cdk2ap1		St6galnac6
Nr6a1	Dyrk1b	Mnd1	Cdkn2c		Stag3
Nt5e	Dyrk2	Mov10	Cdkn3		Stk39
Nudt8	Dyrk4	Mrpl27	Cdr2		Ston1
Olfm1	Dzank1	Mrpl51	Cdt1		Susd1
Olfm2	Dzip1	Msh6	Ceacam1		Syce2
Olig3	Echdc2	Msl3l2	Cebpg		Syngr1
Osgin1	Eef2kmt	Msmo1	Celf5		Syngr3
Ovgp1	Efcab6	Mtbp	Celsr2		Tbc1d7
P4ha2	Egf	Mthfd2	Cenpa		Tesc
Padi2	Egfl8	Mvd	Cenpc1		Tet1
Pafah2	Eif2ak3	Mxd1	Cenpe		Tex15

Pard3	Elmsan1	Mxra8	Cenpf		Tg
Parvb	Elovl7	Myb	Cenph		Thoc6
Pcdh19	Eme2	Mybl2	Cenpi		Ticam2
Pcdhgb6	Eml5	Mylpf	Cenpk		Timeless
Pclo	Eml6	Nab2	Cenpl		Tlcd1
Pctp	Enpp2	Nasp	Cenpm		Tlcd2
Pde1b	Enpp4	Natd1	Cenpn		Tmcc2
Pde9a	Enpp5	Ncf1	Cenpo		Tmem108
Pdlim4	Entpd1	Ncs1	Cenpp		Tmem120b
Pfkfb2	Entpd6	Ndc80	Cenps		Tmem263
Pgr	Epx	Ndufa4	Cenpt		Tmem9
Phf21b	Ern1	Neu3	Cenpu		Tmie
Pid1	Erp27	Nfix	Cenpv		Tnfrsf4
Pigz	Errfi1	Nmnat1	Cenpw		Tox
Pkd1l3	Espnl	Nmral1	Cep128		Tpmt
Pla2g6	Etfbkmt	Noxred1	Cep55		Tpst1
Plaur	Evi2	Nr4a1	Cep57		Trib1
Plcb3	Evi5	Nr4a3	Cep57l1		Trp53inp2
Plcg2	Eya2	Nrbp2	Cep70		Tspan6
Plekha6	Ezh1	Nrgn	Cep72		Tuft1
Plp1	F2r	Nsd2	Cep76		Twsg1
Plxdc2	F2rl2	Nsdhl	Cep78		Tyms
Plxna4	F830016B08Rik	Nsmce1	Cep83		Ube2l6
Prkcz	Fam109a	Ntf5	Cep89		Utp14b
Prkd3	Fam117a	Nudt22	Cers6		Vav2
Prkx	Fam120b	Nup210l	Cetn4		Vps37d
Prpf40b	Fam120c	Nup37	Cfap77		Wdhd1
Prr5	Fam13b	Nup62	Chac1		Wdr76
Prss16	Fam160a2	Nyap1	Chaf1a		Wdr90
Psd2	Fam174b	Orc6	Chaf1b		Zfp101
Ptger3	Fam189b	Pabpc1l	Chchd10		Zfp365
Pts	Fam19a3	Panx1	Chd3os		Zfp367
Pvrig	Fam214a	Pcgf5	Chd5		Zfp870
Pyroxd2	Fam214b	Pdcd1	Chek1		Zgrf1
Qrfp	Fam217b	Pdgfb	Chml		
Qtrt2	Fam241b	Pdk3	Chrm4		
Rab20	Fam71b	Phactr2	Chtf18		
Rab25	Fam78b	Phf19	Cisd1		
Rab27b	Fam81a	Phlda1	Cit		
Rab6b	Fam83b	Phlpp2	Ckap2		

Raver2	Fam83h	Pik3c2b	Ckap2l		
Reck	Fasl	Pkib	Ckap5		
Rflnb	Fastkd1	Plagl1	Ckm		
Ric3	Fat3	Plcl1	Cks1b		
Riiad1	Fbxl12	Pld4	Cks1brt		
Rnf130	Fbxl2	Plek	Cks2		
Rnf217	Fbxl20	Plekho1	Clec12a		
Rpl12	Fbxl21	Plk4	Clic4		
Rpl22l1	Fbxo32	Plpp1	Clip2		
Rpl30	Fcrl6	Plxnb1	Clip3		
Rpl37a	Fgd3	Plxnd1	Clspn		
Rps19	Fgf13	Pml	Cmc2		
Rps21	Fgl2	Pmvk	Cmtm7		
Rps28	Flad1	Pold3	Cnksr3		
Rrm2b	Flcn	Pole2	Cnn3		
Rrp12	Flt3l	Pop1	Cnnm4		
Rsad1	Fn3k	Pou2f2	Cnot9		
Rubcnl	Fndc10	Ppp1r16b	Cntd1		
Runx2	Fndc4	Ppp1r26	Cntrob		
Rwdd3	Foxo1	Prim1	Col18a1		
Sarm1	Foxo3	Pros1	Commd1		
Sbsn	Foxq1	Prss2	Cops4		
Scn8a	Fpgt	Psd3	Copz2		
Sec31b	Frat1	Ptgfrn	Coq3		
Sept8	Frat2	Ptms	Coq7		
Setbp1	Frg2f1	Ptpn3	Coro2a		
Sez6l2	Frmd4a	Ptpn6	Cox6a2		
Sgms1	Fryl	Ptprf	Cox6b2		
Sgsh	Fsd1l	Pxmp2	Cox7a1		
Sh2d4b	Fut8	Pycard	Cpm		
Sh2d5	Fv1	Rasgef1a	Cpt1c		
Sh3bgrl2	Fxyd4	Rasgef1b	Crip1		
Shb	Gab3	Rbl1	Crip2		
Shpk	Gabbr1	Rcan3	Crocc		
Six3	Gabrb3	Rdh11	Crybg2		
Slc22a4	Galnt10	Recql4	Crybg3		
Slc25a27	Galnt11	Rest	Cryl1		
Slc25a37	Galnt14	Rfc2	Cryz		
Slc25a53	Gas7	Rfc3	Cse1l		
Slc26a11	Gbp8	Rfc5	Csrp1		

Slc26a8	Gcm2	Rgs10	Csrp2		
Slc39a11	Gcnt2	Ripply3	Cst6		
Slc7a4	Gda	Rnaseh2b	Ctc1		
Snx13	Gfra2	Rnf168	Cth		
Snx14	Ggnbp1	Rnf208	Ctla4		
Sorbs3	Gigyf1	Rpa2	Ctnnal1		
Sorl1	Gimap3	Rtl8a	Ctnnbip1		
Sp6	Gimap8	Sall2	Ctps		
Specc1	Gjd3	Sass6	Cul7		
Speg	Gldc	Serinc5	Cxcl16		
Spryd7	Gm1043	Sfmbt2	Cxcr5		
Srgap3	Gm10767	Sh3bp2	Cxxc5		
Sspo	Gm12216	Sh3gl3	Cyb561		
St6galnac5	Gm14305	Sh3rf1	Cyp11a1		
Stard9	Gm14325	Sik1	Cyp20a1		
Stc1	Gm14432	Six5	Cyp2u1		
Stc2	Gm20219	Slamf1	Cyp51		
Ston2	Gm35339	Slc12a4	Cystm1		
Suco	Gm4070	Slc15a3	D630045J12Rik		
Sulf2	Gm42372	Slc1a4	Dao		
Sult4a1	Gm45929	Slc25a13	Dapk1		
Suox	Gm527	Slc31a1	Dars2		
Susd4	Gm6904	Slc43a1	Dbf4		
Syt6	Gnao1	Slc43a3	Dbi		
Sytl3	Gngt2	Slc4a11	Dcbld1		
Taf4b	Gnptg	Slc9b2	Dck		
Tagap1	Gns	Slfn3	Dclk2		
Tarm1	Golga1	Smc5	Dclre1a		
Taz	Golm1	Smim3	Dctpp1		
Tdrd12	Gpc1	Smo	Dcxr		
Tdrd3	Gpn1	Snn	Ddah2		
Tdrp	Gpr132	Snx25	Ddias		
Tfap2a	Gpr137b	Spin4	Ddn		
Tgm7	Gpr15	Spock2	Ddr1		
Thbs1	Gpr45	Spred1	Ddx1		
Tiparp	Gpr87	Sqle	Ddx25		
Tle1	Gramd3	St3gal2	Ddx39		
Tle2	Gramd4	St6galnac6	Dek		
Tma16	Grcc10	Stag3	Depdc1a		
Tmcc1	Grid1	Stk39	Depdc1b		

Tmem116	Grina	Ston1	Dera		
Tmem121b	Grk3	Stx11	Dgat2		
Tmem176a	Grk4	Susd1	Dgkd		
Tmem176b	Grtp1	Sv2a	Dgkg		
Tmem55a	Gsap	Syce2	Dgkh		
Tmem80	Gsto1	Syngr1	Dhcr7		
Tmem86a	Gtf2ird2	Syngr3	Dhdh		
Tnfrsf22	Guca1b	Synj2	Dhfr		
Tnfrsf23	Gvin1	Syp	Dhrs13		
Tnfrsf26	Gzmc	Syt11	Diaph3		
Tob1	Gzmd	Tbc1d7	Dio2		
Tom1l1	Gzme	Tbc1d9	Dlc1		
Top1mt	Gzmf	Tert	Dlg3		
Tpbgl	Gzmg	Tesc	Dlgap5		
Tpgs2	Gzmm	Tet1	Dmc1		
Trim47	H2afj	Tex15	Dmpk		
Trim65	H2-Ke6	Tg	Dmwd		
Trio	Hal	Tgif2	Dna2		
Trpc6	Hbp1	Thoc6	Dnajb3		
Trpm1	Hcn3	Thoc7	Dnajb5		
Trpm2	Hcst	Ticam2	Dnajc10		
Trub1	Hdac11	Timeless	Dnajc6		
Tshz3	Hdhd5	Timp2	Dnajc9		
Tspan13	Heatr9	Tlcd1	Dnase2a		
Tspan4	Hectd4	Tlcd2	Dnm1		
Ttbk1	Herc1	Tmcc2	Dnmt1		
Ttc28	Herc2	Tmem108	Dnmt3a		
Ttc41	Hgfac	Tmem120b	Dnph1		
Ttll3	Hic1	Tmem173	Dntt		
Txnip	Hid1	Tmem263	Dpf1		
Ube2cbp	Hist3h2a	Tmem9	Dpy30		
Uggt2	Hivep2	Tmie	Dpysl2		
Ulk2	Hmbox1	Tmprss13	Dpysl5		
Unc5a	Hopx	Tnfrsf4	Drc3		
Usp3	Hoxa4	Tnks1bp1	Drp2		
Vps13b	Hoxb4	Tns1	Dscc1		
Wdr95	Hpgds	Tns4	Dsn1		
Xpc	Hsd17b11	Tox	Dtl		
Yes1	Icam5	Tpmt	Dusp10		
Zbtb10	Ice2	Tpst1	Dusp22		

Zfp202	Idnk	Tram2	Dusp4		
Zfp420	Ier5	Trib1	Dut		
Zfp493	Iffo1	Trp53inp2	Dynlt1a		
Zfp652	Ifitm10	Tspan6	Dynlt1f		
Zfp661	Ifngr2	Tssc4	Dyrk3		
Zfp950	Igf2bp2	Tuft1	E130308A19Rik		
Zfp970	Igfbp4	Twsg1	E2f1		
Zfp991	Igip	Txndc16	E2f2		
Zfp992	Ikbkb	Tyms	E2f7		
Zfr2	Ikbke	Ube2l6	E2f8		
Zrsr1	Ikzf3	Utp14b	Eaf2		
	Il10rb	Vav2	Ect2		
	Il11ra1	Vps37d	Efcab11		
	Il15	Wdhd1	Efcab12		
	Il18	Wdr76	Efemp2		
	Il18bp	Wdr90	Egfl7		
	Il18r1	Wsb2	Egr2		
	Il27ra	Zbtb3	Ehd1		
	Il4ra	Zbtb32	Ehd2		
	Il7	Zfp101	Ehd4		
	Impact	Zfp286	Eif2s2		
	Impg2	Zfp365	Eif4e		
	Ing4	Zfp367	Eif4ebp1		
	Inha	Zfp467	Elfn2		
	Iqcd	Zfp827	Eme1		
	Irak2	Zfp870	Emilin1		
	Irgq	Zgrf1	Enah		
	Irs1		Endou		
	Itga1		Eng		
	Itga10		Enkd1		
	Itga2b		Eno2		
	Itga9		Enpp1		
	Itgb1		Enthd1		
	Itgb3		Epb41l2		
	Itgb7		Epb41l5		
	Itpr2		Ephx1		
	Itpripl2		Epn2		
	Izumo4		Epor		
	Jade2		Erc1		
	Jak1		Ercc6l		

	Jmjd8		Erfe		
	Jmy		Eri1		
	Jun		Ermn		
	K230010J24Rik		Esco2		
	Kat2b		Esm1		
	Kat6b		Espl1		
	Kbtbd11		Espn		
	Kcnip3		Ets2		
	Kcnj8		Etv4		
	Kctd12		Etv5		
	Kctd15		Evc		
	Kctd21		Exo1		
	Kdm4d		Exosc8		
	Khdc1a		Ext1		
	Kifc2		Extl1		
	Kifc3		Extl3		
	Kirrel		Ezh2		
	Klf3		Faap24		
	Klf4		Fabp5		
	Klhl17		Fads2		
	Klhl21		Fah		
	Klhl24		Fam109b		
	Klhl30		Fam110a		
	Klhl4		Fam124b		
	Klra2		Fam129b		
	Klrc2		Fam162a		
	Klrg1		Fam171a1		
	Kmt2a		Fam171b		
	Kmt2c		Fam183b		
	Kmt2d		Fam212a		
	Kmt5b		Fam213a		
	Krt83		Fam216a		
	Krtcap3		Fam221a		
	Kyat1		Fam60a		
	L1cam		Fam72a		
	Lactbl1		Fam83d		
	Large1		Fam83g		
	Lats2		Fam92a		
	Lax1		Fanca		
	Lbp		Fancb		

	Lcn12		Fancd2	
	Lcn4		Fanci	
	Lcor		Fancl	
	Ldlrad1		Fancm	
	Ldlrad4		Farp1	
	Lef1		Fas	
	Leng8		Fbln1	
	Leng9		Fbxo2	
	Lgals3		Fbxo36	
	Lhfpl1		Fbxo48	
	Lhx6		Fbxo5	
	Lilrb4a		Fcmr	
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	Lime1		Fdps	
	Lmbr1		Fen1	
	Lmo7		Fes	
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	LOC108168164		Fgd6	
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	Lpar6		Fgfr1op	
	Lpcat2		Fibcd1	
	Lpp		Fignl1	
	Lrch4		Fkbp11	
	Lrp11		Fkbp1a	
	Lrp6		Fkbp1b	
	Lrrc24		Fkbp2	
	Lrrc75b		Fkbp3	
	Lrrc8e		Fkbp5	
	Lrrk1		Flywch2	
	Lrrn4		Fmnl3	
	Lysmd1		Fnbp1l	
	Lyst		Fndc3b	
	Macf1		Foxk2	
	Maf		Foxm1	
	Mageh1		Foxp3	
	Maml3		Frem2	
	Man2a2		Frrs1l	
	Maneal		Fsbp	
	Map3k13		Fscn1	
	Map3k15		Fut10	

	Map3k2		Fut4	
	Map4k3		Fxn	
	Mapk1ip1		Fxyd7	
	Mapk8ip1		Fzr1	
	Mapkapk5		G2e3	
	Mapre3		Gab2	
	March3		Gabrr2	
	Masp2		Gadd45b	
	Mbnl1		Gale	
	Mbp		Galk1	
	Mccc1		Gamt	
	Mcl1		Gapdh	
	Mcoln2		Gapdh-ps15	
	Mcpt8		Gars	
	Mdm4		Gas2	
	Mdn1		Gas2l3	
	Mef2b		Gatad1	
	Megf11		Gatm	
	Mei1		Gbe1	
	Meis3		Gca	
	Metap1d		Gcat	
	Metrnl		Gclm	
	Mettl27		Gcnt4	
	Mettl7a1		Gem	
	Mfng		Gemin6	
	Mgat4a		Gen1	
	Mib2		Gins1	
	Mink1		Gins2	
	Mmaa		Gins3	
	Mn1		Gipc1	
	Mospd1		Gipc3	
	Mppe1		Gipr	
	Ms4a6c		Gk	
	Mthfsd		Gk5	
	Mtmr3		Glrp1	
	Mxd4		Gls2	
	Mycbp2		Gltp	
	Myl10		Gm12260	
	Mylip		Gm128	
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	Myo3b		Gm20604		
	Myof		Gm21596		
	Myrip		Gm21948		
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	N4bp2l1		Gm29721		
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	Nacc2		Gm4969		
	Nagpa		Gm5134		
	Naip2		Gm996		
	Naip5		Gmds		
	Naip6		Gmnn		
	Naip7		Gnaz		
	Nat10		Gnb4		
	Nav2		Gng3		
	Nbeal1		Gnptab		
	Nbeal2		Golt1b		
	Ncald		Gorasp1		
	Ncam2		Gpat3		
	Nckap5l		Gpld1		
	Ncr1		Gpm6b		
	ND4		Gpr162		
	ND5		Gpr183		
	Ndnf		Gpr19		
	Ndor1		Gprc5b		
	Nedd4		Gprin3		
	Nedd4l		Gpsm2		
	Neu1		Gpt2		
	Nfe2l2		Gpx7		
	Nfkbiz		Grhl1		
	Nhsl2		Grin1		
	Nin		Gstp2		
	Nipa1		Gstt1		
	Nipal3		Gstt2		
	Nlrp1b		Gstt3		
	Nlrp3		Gtdc1		
	Nlrp6		Gtf2e2		
	Nmnat3		Gtf2ird1		
	Nod1		Gtf3c5		
	Notch2		Gtse1		

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	Npff		Gucy1a3	
	Nptn		Gucy1b3	
	Nr1d1		Gzmk	
	Nr1d2		H1f0	
	Nr1h3		H2afv	
	Nr6a1		H2afx	
	Nt5e		H2afz	
	Ntng2		H2-Q2	
	Nudt6		Hacd1	
	Nupr1l		Hacl1	
	Obscn		Haspin	
	Obsl1		Hat1	
	Odaph		Haus1	
	Ogt		Haus4	
	Olfm1		Haus5	
	Olfml3		Haus6	
	Olig3		Haus7	
	Oplah		Hccs	
	Orai2		Hck	
	Ormdl3		Hdac6	
	Osbpl5		Hdgf	
	Osgin1		Hebp1	
	Otof		Hectd2	
	Otud3		Helb	
	Ovgp1		Hells	
	Padi2		Helq	
	Pak6		Hemgn	
	Pard3		Hesx1	
	Parm1		Hexim2	
	Parp12		Hhat	
	Parp8		Hic2	
	Pcdhga12		Hif1a	
	Pcdhgb4		Hint1	
	Pced1b		Hipk4	
	Pclo		Hirip3	
	Pcnx		Hist1h1a	
	Pctp		Hist1h1b	
	Pdcd4		Hist1h1c	
	Pde11a		Hist1h1d	

	Pde1b		Hist1h1e	
	Pde6g		Hist1h2ab	
	Pdgfa		Hist1h2ac	
	Pdk2		Hist1h2ae	
	Pdlim4		Hist1h2af	
	Pdlim5		Hist1h2ag	
	Pdrg1		Hist1h2ak	
	Pdzd2		Hist1h2an	
	Pdzd4		Hist1h2bb	
	Pdzrn3		Hist1h2be	
	Pea15a		Hist1h2bg	
	Peak1		Hist1h2bj	
	Peli3		Hist1h2bk	
	Per3		Hist1h2bl	
	Perm1		Hist1h2bn	
	Pfkfb2		Hist1h3a	
	Pgr		Hist1h3b	
	Phf1		Hist1h3c	
	Phf11d		Hist1h3d	
	Phf20l1		Hist1h3e	
	Phf21a		Hist1h3f	
	Phf21b		Hist1h3g	
	Phka1		Hist1h3h	
	Pid1		Hist1h3i	
	Pigz		Hist1h4b	
	Pik3ip1		Hist1h4c	
	Pik3r5		Hist1h4d	
	Pilrb1		Hist1h4f	
	Pilrb2		Hist1h4h	
	Pkd1		Hist1h4i	
	Pkd1l3		Hist1h4j	
	Pkd2		Hist1h4k	
	Plcb2		Hist2h2ac	
	Plcd1		Hist2h2bb	
	Plcl2		Hist2h3b	
	Plec		Hist2h4	
	Plekha1		Hjurp	
	Plekhm3		Hlf	
	Plekhn1		Hmbs	
	Plp1		Hmga1	

	Plpp6		Hmgb1	
	Plscr2		Hmgb2	
	Plscr4		Hmgb3	
	Plxdc2		Hmgcr	
	Pnisr		Hmgcs1	
	Pnpla6		Hmgn1	
	Pnpla7		Hmgn2	
	Pnpo		Hmgn3	
	Pnrc1		Hmgn5	
	Podnl1		Hmmr	
	Podxl		Hmox1	
	Pogk		Hmx2	
	Pot1b		Hnrnpa1	
	Pou4f1		Hnrnpa1l2-ps2	
	Pou6f1		Hnrnpa3	
	Ppargc1a		Hnrnpab	
	Ppargc1b		Hnrnpd	
	Ppm1h		Hook1	
	Ppm1j		Hormad2	
	Ppp1r13b		Hpdl	
	Ppp1r3d		Hpf1	
	Ppp1r3e		Hrc	
	Ppp2r2c		Hsd17b7	
	Ppp2r5a		Hsf2	
	Ppp3ca		Hsp90aa1	
	Prex1		Hspa12a	
	Prickle3		Hspa2	
	Prkce		Hspa4l	
	Prkcz		Hspb6	
	Prkd3		Htra2	
	Prkx		Hyls1	
	Prr22		Id3	
	Prr5		Idh2	
	Prrt1		Idi1	
	Prss16		Ifng	
	Prss30		Ift46	
	Psd2		Ift80	
	Psg17		Ift81	
	Ptgdr2		Igf1r	
	Ptger3		Igf2bp3	

	Ptges		Igsf23		
	Ptpn4		Iigp1		
	Ptpn9		Ikzf2		
	Ptpre		Il17rd		
	Ptprj		Il1rl1		
	Pvrig		Il1rl2		
	Pxdc1		Il24		
	Pyroxd2		Il2ra		
	Qpct		Il4i1		
	Qtrt1		Il6st		
	Qtrt2		Il7r		
	Rab20		Ildr1		
	Rab27b		Incenp		
	Rab36		Inpp5f		
	Rab6b		Insig1		
	Rabggta		Intu		
	Rap1gap2		Ipo5		
	Rasa3		Ipo7		
	Rasal3		Ipp		
	Rbm20		Iqcb1		
	Rdh5		Iqgap3		
	Reck		Irak1bp1		
	Ret		Irak3		
	Rfx3		Irf4		
	Rfx5		Irf6		
	Rgl2		Irf8		
	Rhbdl1		Islr		
	Rimkla		Itga5		
	Ripor2		Itgae		
	Ripor3		Itgb4		
	Rnf122		Itih5		
	Rnf144b		Itm2a		
	Rnf152		Itpa		
	Rnf166		Itpka		
	Rnf167		Izumo1r		
	Rora		Jag2		
	Rpgrip1		Jcad		
	Rps19		Jph4		
	Rps21		Jpt2		
	Rps24		Jup		

	Rps28		Katnal2		
	Rptor		Kbtbd6		
	Rrp12		Kcna2		
	Rsad1		Kcnb1		
	Rslcan18		Kcnc1		
	Rsrp1		Kcnh3		
	Rtl8c		Kdm8		
	Rtn4rl1		Kif11		
	Rundc3a		Kif14		
	Rundc3b		Kif15		
	Rwdd3		Kif18a		
	Rxra		Kif18b		
	Ryk		Kif20a		
	Ryr3		Kif20b		
	S100a4		Kif22		
	S100a6		Kif23		
	S1pr1		Kif24		
	S1pr4		Kif2c		
	Samd3		Kif4		
	Samd9l		Kif5a		
	Saraf		Kif7		
	Sarm1		Kifc1		
	Sat1		Kifc5b		
	Satb1		Klc3		
	Sbsn		Klf11		
	Scd4		Klf7		
	Scin		Klhdc9		
	Scml4		Klhl23		
	Sdc2		Klhl5		
	Sec31b		Klra1		
	Sema6d		Klra15		
	Sept8		Klra19		
	Sesn1		Klra22		
	Setbp1		Klra3		
	Sez6l2		Klra6		
	Sfxn3		Klrb1f		
	Sgk1		Klri2		
	Sgsh		Kmo		
	Sh2d1b1		Kmt5a		
	Sh2d3c		Knl1		

	Sh3bp5		Knstrn		
	Shank1		Kntc1		
	Shisa5		Kpna2		
	Shpk		Kpna3		
	Sike1		Kras		
	Sirt5		Kremen2		
	Six3		Ksr1		
	Slc11a2		Lacc1		
	Slc12a3		Lad1		
	Slc16a2		Lag3		
	Slc17a9		Lamc2		
	Slc24a3		Lancl2		
	Slc25a27		Larp1b		
	Slc25a45		Lca5		
	Slc25a53		Lclat1		
	Slc26a11		Ldhb		
	Slc26a6		Ldlr		
	Slc26a8		Leo1		
	Slc27a6		Lgalsl		
	Slc31a2		Lif		
	Slc35e4		Lig1		
	Slc36a1		Lin54		
	Slc38a7		Lin9		
	Slc3a1		Lipg		
	Slc41a2		Litaf		
	Slc46a1		Lmf2		
	Slc4a1ap		Lmna		
	Slc4a4		Lmnb1		
	Slc7a4		Lmnb2		
	Slc9a9		Lmtk3		
	Slco2a1		Lnpk		
	Slco3a1		Lonp1		
	Slfn1		Lonrf1		
	Slfn2		Lpar2		
	Smad3		Lpcat1		
	Smarca2		Lpin3		
	Smg1		Lrfn4		
	Smim10l1		Lrmp		
	Smim14		Lrp1		
	Smim27		Lrp8		

	Smim4		Lrr1		
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	Smpd5		Lrrc40		
	Smug1		Lrrc59		
	Sntb2		Lrrc71		
	Snx29		Lrrc75a		
	Snx32		Lrrc8b		
	Soat2		Lsm2		
	Socs3		Lsm3		
	Sorbs3		Lsm5		
	Sorcs2		Lsr		
	Sorl1		Lst1		
	Spag1		Ltk		
	Spata13		Ly6a		
	Specc1		Lyar		
	Speg		Lzts1		
	Spns1		Mad1l1		
	Spo11		Mad2l1		
	Spp1		Maged1		
	Sppl2b		Maged2		
	Spr		Magi3		
	Sptbn2		Man1c1		
	Spx		Manf		
	St3gal6		Mansc1		
	Stc2		Maoa		
	Stk32c		Map1a		
	Ston2		Map2		
	Styk1		Map2k6		
	Suco		Map3k19		
	Sulf2		Map3k6		
	Sult4a1		Map3k9		
	Susd4		Map7		
	Susd6		Map9		
	Syt3		Mapk11		
	Syt6		Mapk6		
	Tanc2		Mapkapk2		
	Tas1r3		Marcksl1		
	Taz		Mars		
	Tbc1d10c		Marveld2		
	Tbc1d12		Mast2		

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	Tbc1d17		Matk		
	Tbx6		Mb21d1		
	Tcf24		Mbd4		
	Tcn2		Mblac1		
	Tcp11l2		Mboat7		
	Tcta		Mcam		
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	Tdrd7		Mcm2		
	Tdrp		Mcm3		
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	Teddm2		Mcm5		
	Tef		Mcm6		
	Tfap2a		Mcm7		
	Tgfa		Mcm8		
	Tgfb1i1		Mctp1		
	Tgm2		Mcu		
	Tgm4		Mdm1		
	Tha1		Me1		
	Thbs1		Me2		
	Thtpa		Med7		
	Tjp1		Megf9		
	Tk2		Melk		
	Tle4		Metrn		
	Tlr12		Mfhas1		
	Tlr4		Mfsd13a		
	Tm6sf2		Mfsd2a		
	Tmc6		Mical2		
	Tmem119		Micall2		
	Tmem140		Milr1		
	Tmem151a		Minpp1		
	Tmem154		Mipep		
	Tmem159		Mis12		
	Tmem176a		Mis18a		
	Tmem176b		Mis18bp1		
	Tmem198		Mki67		
	Tmem42		Mmp11		
	Tmem63a		Mmp14		
	Tmem63b		Mmp15		
	Tmem64		Mms22l		

	Tmem71		Mnd1	
	Tmem8		Mns1	
	Tmem80		Morn1	
	Tmod4		Mpeg1	
	Tmppe		Mpp2	
	Tmtc1		Mpp6	
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	Tnfrsf14		Mpzl2	
	Tnfrsf22		Mrnip	
	Tnfrsf23		Ms4a4a	
	Tnfrsf26		Ms4a4d	
	Tnfsf4		Msh5	
	Tnfsf8		Msh6	
	Tnrc6b		Msmo1	
	Tob1		Mst1	
	Tob2		Mt1	
	Tom1l1		Mt2	
	Tom1l2		Mt3	
	Tpbgl		Mtbp	
	Tpgs2		Mtfr2	
	Tppp3		Mthfd1l	
	Tpst2		Mthfd2	
	Trim16		Mtmr14	
	Trim2		Mutyh	
	Trim26		Mvd	
	Trim65		Mvk	
	Trio		Mxd3	
	Trip4		Mxra8	
	Trip6		Mybl1	
	Trp53inp1		Mybl2	
	Trpc6		Mycl	
	Tspan17		Myef2	
	Tssk4		Myh10	
	Ttc38		Myh7b	
	Ttll3		Myl6b	
	Tub		Mylpf	
	Tulp4		Myo1c	
	Tusc1		Myo1h	
	Tusc2		Myrf	
	Txk		Mzt1	

	Txnip		Naaladl1	
	Uba7		Nab2	
	Ubn2		Nampt	
	Ubr4		Nap1l1	
	Ubxn6		Naprt	
	Unc5a		Nasp	
	Upk1b		Ncapd2	
	Upp1		Ncapd3	
	Usp48		Ncapg	
	Ust		Ncapg2	
	Utrn		Ncaph	
	Uvssa		Ncaph2	
	Vav3		Ncf1	
	Vezf1		Ncf2	
	Vpreb1		Ncmap	
	Vps13c		Ncs1	
	Vps13d		Ndc1	
	Vsir		Ndc80	
	Wars2		Nde1	
	Wdr45		Ndrg2	
	Wdr49		Ndufa4	
	Wdr81		Neb	
	Wdr82		Nebl	
	Wdr95		Necab3	
	Wls		Nectin2	
	Xcl1		Nedd1	
	Xkr6		Neil3	
	Yes1		Nek2	
	Ypel3		Nek6	
	Zbtb20		Nelfcd	
	Zbtb37		Nelfe	
	Zbtb4		Nemp1	
	Zbtb40		Nenf	
	Zc2hc1a		Neu3	
	Zcchc18		Neurl1b	
	Zcchc7		Nfatc2ip	
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	Zdhhc17		Nfyb	
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	Zfc3h1		Nlgn2	

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	Zfp14		Nme4	
	Zfp169		Nme6	
	Zfp235		Nmral1	
	Zfp276		Noct	
	Zfp28		Notch3	
	Zfp287		Noxred1	
	Zfp316		Nphp1	
	Zfp317		Nphp3	
	Zfp369		Nphp4	
	Zfp36l2		Npl	
	Zfp420		Nqo1	
	Zfp456		Nr4a1	
	Zfp458		Nr4a2	
	Zfp493		Nr4a3	
	Zfp512		Nrap	
	Zfp523		Nrbp2	
	Zfp579		Nrg4	
	Zfp595		Nrgn	
	Zfp619		Nrm	
	Zfp623		Nrn1	
	Zfp652		Nrp1	
	Zfp658		Nsd2	
	Zfp661		Nsdhl	
	Zfp738		Nsl1	
	Zfp78		Nsmce1	
	Zfp85		Nt5dc2	
	Zfp871		Ntf5	
	Zfp874a		Ntn3	
	Zfp874b		Nucks1	
	Zfp882		Nuf2	
	Zfp932		Nup107	
	Zfp94		Nup133	
	Zfp945		Nup155	
	Zfp950		Nup160	
	Zfp970		Nup205	
	Zfp971		Nup37	
	Zfp992		Nup43	
	Zgpat		Nup54	

	Zhx2		Nup62	
	Zkscan14		Nup85	
	Zkscan7		Nup93	
	Zmat3		Nupr1	
	Znrf3		Nusap1	
	Zrsr1		Nxt1	
	Zscan26		Nyap1	
	Zswim8		Oaf	
	Zzef1		Odc1	
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			Odf2l	
			Oip5	
			Olfr56	
			Orc1	
			Orc6	
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			Oscp1	
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			Pacsin3	
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			Pak4	
			Palb2	
			Palm	
			Paox	
			Papd7	
			Paqr3	
			Paqr4	
			Paqr8	
			Pard6g	
			Parpbp	
			Pask	
			Paxip1	
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			Pbk	
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			Pcdhgc4	

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			Pcx		
			Pdcd1		
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			Pdgfrb		
			Pdia5		
			Pdik1l		
			Pdk3		
			Pdp1		
			Pdss1		
			Pdzd11		
			Penk		
			Perp		
			Pfas		
			Pfn2		
			Pgm1		
			Pgp		
			Phactr2		
			Phf19		
			Phgdh		
			Phldb1		
			Phtf2		
			Pi4k2b		
			Pianp		
			Pidd1		
			Pif1		
			Pigf		
			Pik3cg		
			Pik3r6		
			Pim2		
			Pimreg		
			Pkib		
			Pkig		
			Pkmyt1		
			Pkn3		

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			Plcb4		
			Plcl1		
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			Plekhf2		
			Plekhg2		
			Plekhg4		
			Plekho1		
			Plk1		
			Plk2		
			Plk4		
			Plp2		
			Plpp1		
			Plxna3		
			Plxnb1		
			Plxnb2		
			Plxnd1		
			Pmel		
			Pmf1		
			Pml		
			Pmvk		
			Pnck		
			Pnp2		
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			Poc1b		
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			Pola2		
			Pold1		
			Pold3		
			Pole		
			Pole2		
			Polh		
			Polq		
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			Pomt1		
			Pop4		
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			Ppa1		
			Ppat		
			Ppfibp1		

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			Ppp1r35		
			Ppp2r3a		
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			Prcp		
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			Prelid3b		
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			Prim2		
			Primpol		
			Prkch		
			Prpf38a		
			Prps1		
			Prr11		
			Prss41		
			Prx		
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			Psip1		
			Psmc3ip		
			Psmd1		
			Psmg1		
			Pspc1		
			Pstpip2		
			Pter		
			Ptgfrn		
			Ptgir		
			Ptgr1		
			Ptma		
			Ptms		
			Ptpn6		
			Ptprk		
			Ptprs		
			Pxmp2		
			Pycr1		

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			Rab39b		
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			Rad18		
			Rad21		
			Rad51		
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			Rad51b		
			Rad51c		
			Rad54b		
			Rad54l		
			Ralb		
			Raly		
			Ran		
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			Rfx4		
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			Rhpn2		
			Ribc1		
			Rims3		
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			Rnd2		
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			Rnf168		
			Rnf19b		
			Rnf208		
			Rnf216		
			Rnf26		
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			Ropn1l		
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			Rps6ka6		
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			Rrm2		
			Rsph1		
			Rtkn		
			Rtkn2		
			Rtn3		
			Rubcnl		
			Runx1		
			Saal1		
			Sae1		
			Samd11		
			Sap30		
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			Scarb1		
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			Scpep1		
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			Sema4g		
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			Sema7a		
			Sephs1		
			Sept10		
			Serinc3		
			Serinc5		
			Serpinb1b		
			Serpinb6b		
			Serpinb9		
			Serpinf1		
			Sestd1		

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			Sgo2a		
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			Sh3tc1		
			Shcbp1		
			Shmt1		
			Shmt2		
			Shroom3		
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			Siah2		
			Sik1		
			Siva1		
			Ska1		
			Ska2		
			Ska3		
			Skp2		
			Slamf1		
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			Slc25a43		
			Slc26a10		
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			Slc31a1		
			Slc35d3		
			Slc3a2		
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			Slc4a8		
			Slc6a13		
			Slc6a9		
			Slc7a1		
			Slc7a3		
			Slc7a5		
			Slc9a5		
			Slc9b2		
			Slfn3		
			Smc1a		
			Smc2		
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			Smc4		
			Smc5		
			Smc6		
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			Smpdl3b		
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			Sms-ps		
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			Snrnp35		
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			Snx9		
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			Sowahc		
			Sox12		
			Sox4		
			Spaca1		
			Spag4		
			Spag5		
			Spata24		
			Spats1		
			Spats2l		
			Spc24		
			Spc25		

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			Spidr		
			Spire1		
			Spock2		
			Spred1		
			Spry1		
			Spry4		
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			Sqle		
			Srl		
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			Srsf4		
			Ssbp3		
			Ssx2ip		
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			St6galnac3		
			St6galnac6		
			Stag3		
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			Stard13		
			Stard3nl		
			Stard4		
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			Stbd1		
			Stil		
			Stk38l		
			Stk39		
			Stmn1		
			Stom		
			Ston1		
			Stxbp1		
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			Susd1		
			Suv39h1		
			Suv39h2		
			Suz12		
			Sv2c		
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			Syde1		
			Syngap1		

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			Syngr4		
			Synpo		
			Sypl		
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			Tacc3		
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			Taf6		
			Tank		
			Tarsl2		
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			Tbc1d31		
			Tbc1d7		
			Tbc1d8		
			Tcam1		
			Tceal9		
			Tcf19		
			Tcp1		
			Tctex1d2		
			Tdg		
			Tdg-ps		
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			Tdp2		
			Tedc1		
			Tedc2		
			Terf1		
			Tesc		
			Tet1		
			Tex13d		
			Tex15		
			Tex30		
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			Tfr2		
			Tfrc		
			Tg		
			Tgfb1		

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			Thnsl2		
			Thoc6		
			Thop1		
			Thrb		
			Tiam1		
			Ticam2		
			Ticrr		
			Tigit		
			Timeless		
			Timm17b		
			Tinf2		
			Tipin		
			Tjp3		
			Tk1		
			Tkt		
			Tlcd1		
			Tlcd2		
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			Tmcc2		
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			Tmem108		
			Tmem120b		
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			Tmem25		
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			Tnfrsf4		
			Tnfrsf8		
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			Tnni3		
			Tnnt1		
			Tnp2		
			Tns3		
			Top2a		
			Topbp1		
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			Tpm2		
			Tpm4		
			Tpmt		
			Tpst1		
			Tpx2		
			Traf4		
			Traip		
			Trat1		
			Trdmt1		
			Trib1		
			Trib3		
			Trim45		
			Trim6		
			Trim7		
			Trip13		
			Troap		
			Trp53i11		
			Trp53inp2		
			Trp73		
			Trpm4		
			Trpv4		
			Tsga10		
			Tspan2		
			Tspan3		
			Tspan6		
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			Tuba1b		
			Tuba1c		
			Tuba4a		
			Tuba8		
			Tubb2a		
			Tubb2b		
			Tubb4b		
			Tubb5		
			Tube1		
			Tubg1		
			Tubgcp2		
			Tuft1		
			Twsg1		
			Txn1		
			Txnl1		
			Tyms		
			Uap1		
			Ube2c		
			Ube2e3		
			Ube2l6		
			Ube2s		
			Ube2t		
			Ubtd2		
			Uchl1		
			Uchl5		
			Uevld		
			Ugp2		
			Ugt1a7c		
			Uhrf1		
			Umps		
			Unc93b1		
			Ung		
			Usp1		
			Usp18		
			Usp2		

			Usp44		
			Usp6nl		
			Utf1		
			Utp14b		
			Uxs1		
			Vat1		
			Vav2		
			Vcl		
			Vdac1		
			Vps37d		
			Vrk1		
			Wdfy4		
			Wdhd1		
			Wdpcp		
			Wdr31		
			Wdr35		
			Wdr62		
			Wdr76		
			Wdr90		
			Wee1		
			Wfikkn2		
			Wipi1		
			Wnt10b		
			Wwc1		
			Wwc2		
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			Xk		
			Xkr5		
			Xpnpep1		
			Xpnpep2		
			Xpo1		
			Xrcc2		
			Xrcc3		
			Yars		
			Ybx1		
			Ybx2		
			Ybx3		
			Yif1b		
			Ywhae		
			Ywhah		

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			Zbtb12		
			Zcchc3		
			Zeb2		
			Zfand4		
			Zfp101		
			Zfp280b		
			Zfp318		
			Zfp365		
			Zfp367		
			Zfp382		
			Zfp41		
			Zfp473		
			Zfp52		
			Zfp575		
			Zfp599		
			Zfp608		
			Zfp870		
			Zfp92		
			Zfp948		
			Zgrf1		
			Zranb3		
			Zwilch		

Supplemental Table 5. Sequencing Coverage and Quality Statistics_ RNA sequencing (RNAseq)

Sample ID	Total number of sequenced reads	Total number of uniquely mapped reads	RNA integrity number (RIN)	Ratio of all reads aligned to rRNA regions.	Expression Profile Efficiency	Total number of detected transcripts	group
Sample_456	26099881	8533815	9,3	0.0050468813	0.7628531	33331	IL.7.15_w1_batch3,
Sample_459	39724193	11998646	9,1	0.0009133729	0.75237286	33663	IL.7.15_w4_batch3
Sample_462	23566148	7600295	9,2	0.006043371999999999	0.7484026	33126	IL.7.15_w1_batch4
Sample_465	25697366	8378599	8,9	0.0052117403	0.74760145	32866	IL.7.15_w4_batch4
Sample_474	24382802	8030759	9,5	0.001497777	0.72920936	32455	IL.7.15_w1_batch6
Sample_477	28888177	9336758	9,6	0.0006676434	0.72272176	32503	IL.7.15_w4_batch6
Sample_591	37514081	11940036	9,9	0.0027670944	0.79164356	33887	IL.7.15_w1_batch8,
Sample_595	34934693	11653855	7	0.00453947	0.7498090000000001	33317	IL.7.15_w4_batch8
Sample_599	18475414	7172733	9,3	0.004400713400000001	0.76146996	32333	IL.7.15_w1_batch9
Sample_603	32568258	9635931	9,1	0.005949566	0.74925005	32956	IL.7.15_w4_batch9
Sample_1060	33210709	10807310	9,8	0.0038528538	0.76361513	32731	IL.7.15_w1_batch5
Sample_1063	31574028	10535411	9,5	0.0036153765	0.748688	32681	IL.7.15_w3_batch5
Sample_1066	31506726	10668808	9,8	0.004861978	0.7287857	32872	IL.7.15_w1_batch6
Sample_1069	31700829	10745722	10	0.0033605115000000002	0.76069397	32961	IL.7.15_w3_batch6
Sample_1072	26402533	9253255	10	0.0025941073	0.78328806	32213	IL.7.15_w1_batch7
Sample_1075	33320786	11630924	8,1	0.0077243675	0.7343028	32434	IL.7.15_w3_batch7
Sample_1078	32002243	11069523	9,9	0.0041307416	0.78739476	32630	IL.7.15_w1_batch8