

Angiogenesis

An immature B-cell population from peripheral blood serves as surrogate marker for monitoring tumor angiogenesis and anti-angiogenic therapy in mouse models

Ernesta Fagiani, Ruben Bill, Laura Pisarsky, Curzio Rüegg, Gerhard Christofori

List of molecules specifically localized in plasma membrane and in extracellular space

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Symbol	Entrez Gene Name	Entrez Gene	Networks	Location
ABCA6	ATP-binding cassette, sub-family A (ABC1), member 6	--	13	Plasma Membrane
ABCC8	ATP-binding cassette, sub-family C (CFTR/MRP), member 8	--		Plasma Membrane
ACTR3	ARP3 actin-related protein 3 homolog (yeast)	74117	3	Plasma Membrane
ADM2	adrenomedullin 2	--	8	Extracellular Space
ADORA2A	adenosine A2a receptor	--		Plasma Membrane
AGT	angiotensinogen (serpin peptidase inhibitor, clade A, member 8)	--		Extracellular Space
AGTR1	angiotensin II receptor, type 1	--		Plasma Membrane
ANXA8L2 (includes othe	annexin A8-like 2	--	15	Plasma Membrane
APP	amyloid beta (A4) precursor protein	--		Plasma Membrane
AQP11	aquaporin 11	--	16	Plasma Membrane
B-cell receptor	--	--	5	Plasma Membrane
B2M	beta-2-microglobulin	12010	10	Plasma Membrane
BANK1	B-cell scaffold protein with ankyrin repeats 1	242248	5	Extracellular Space
BCR (complex)	--	--	5	Plasma Membrane
Cadherin	--	--	7	Plasma Membrane
Calmodulin-G protein bet	--	--	17	Plasma Membrane
CAV1	caveolin 1, caveolae protein, 22kDa	--		Plasma Membrane
CD2	CD2 molecule	12481	7	Plasma Membrane
CD3	--	--	11	Plasma Membrane
CD8	--	--	10	Plasma Membrane
CD19	CD19 molecule	12478	5	Plasma Membrane
CD22	CD22 molecule	12483	5	Plasma Membrane
CD28	CD28 molecule	--		Plasma Membrane
CD37	CD37 molecule	12493	5	Plasma Membrane
CD38	CD38 molecule	--		Plasma Membrane
CD44	CD44 molecule (Indian blood group)	--		Plasma Membrane
CD47	CD47 molecule	16423	4	Plasma Membrane
CD52	CD52 molecule	23833	11	Plasma Membrane
CD53	CD53 molecule	12508	2	Plasma Membrane
CD74	CD74 molecule, major histocompatibility complex, class II invariant chain	16149	4	Plasma Membrane
CD81	CD81 molecule	12520	5	Plasma Membrane
CD97	CD97 molecule	26364	11	Plasma Membrane
CD99	CD99 molecule	--		Plasma Membrane
CD164	CD164 molecule, sialomucin	53599	8	Plasma Membrane
Cd24a	CD24a antigen	12484	5	Plasma Membrane
CD40LG	CD40 ligand	--		Extracellular Space
CD79A	CD79a molecule, immunoglobulin-associated alpha	12518	5	Plasma Membrane
CD79B	CD79b molecule, immunoglobulin-associated beta	15985	5	Plasma Membrane
CELA1	chymotrypsin-like elastase family, member 1	--		Extracellular Space

CFTR	cystic fibrosis transmembrane conductance regulator (ATP-binding cassette sub-family C, member 7)	--		Plasma Membrane
CLCN5	chloride channel, voltage-sensitive 5	--		Plasma Membrane
CLCN7	chloride channel, voltage-sensitive 7	--		Plasma Membrane
CLDN7	claudin 7	--		Plasma Membrane
CLEC11A	C-type lectin domain family 11, member A	--		Extracellular Space
Collagen(s)	--	--	11	Extracellular Space
CSF2	colony stimulating factor 2 (granulocyte-macrophage)	--		Extracellular Space
CSF3	colony stimulating factor 3 (granulocyte)	--		Extracellular Space
CST3	cystatin C	13010	4	Extracellular Space
CST4	cystatin S	--	12	Extracellular Space
DSCAML1	Down syndrome cell adhesion molecule like 1	114873	16	Plasma Membrane
DYSF	dysferlin, limb girdle muscular dystrophy 2B (autosomal recessive)	--		Plasma Membrane
EBI3	Epstein-Barr virus induced 3	--		Extracellular Space
EDN1	endothelin 1	--		Extracellular Space
EGF	epidermal growth factor	--		Extracellular Space
EGFR	epidermal growth factor receptor	--	16	Plasma Membrane
EPB42	erythrocyte membrane protein band 4.2	--		Plasma Membrane
EPO	erythropoietin	--		Extracellular Space
ERAP1	endoplasmic reticulum aminopeptidase 1	--		Extracellular Space
ERBB2	v-erb-b2 erythroblastic leukemia viral oncogene homolog 2, neuro/glioblastoma derived oncogene homolog (avian)	--		Plasma Membrane
ERBB3	v-erb-b2 erythroblastic leukemia viral oncogene homolog 3 (avian)	--		Plasma Membrane
ERBB4	v-erb-a erythroblastic leukemia viral oncogene homolog 4 (avian)	--		Plasma Membrane
F2	coagulation factor II (thrombin)	--		Extracellular Space
FAAH	fatty acid amide hydrolase	--		Plasma Membrane
FAIM3	Fas apoptotic inhibitory molecule 3	69169	4	Plasma Membrane
FAM3D	family with sequence similarity 3, member D	--	17	Extracellular Space
Fc gamma receptor	--	--	10	Plasma Membrane
FCAMR	Fc receptor, IgA, IgM, high affinity	--	16	Plasma Membrane
Fcgr1	--	--	10	Plasma Membrane
FGF2	fibroblast growth factor 2 (basic)	--	13	Extracellular Space
FGF7	fibroblast growth factor 7	--		Extracellular Space
FGF10	fibroblast growth factor 10	--		Extracellular Space
FGFR1	fibroblast growth factor receptor 1	--		Plasma Membrane
Fibrinogen	--	--	14	Plasma Membrane
FLT3	fms-related tyrosine kinase 3	--		Plasma Membrane
FLT3LG	fms-related tyrosine kinase 3 ligand	--		Extracellular Space
FNDC1	fibronectin type III domain containing 1	--	17	Plasma Membrane
FOLR1	folate receptor 1 (adult)	--		Plasma Membrane
FSH	--	--	17	Plasma Membrane
GAST	gastrin	--		Extracellular Space
GDNF	glial cell derived neurotrophic factor	--		Extracellular Space
GFRA1	GDNF family receptor alpha 1	--		Plasma Membrane
GH1	growth hormone 1	--		Extracellular Space
Gi-coupled receptor	--	--	14	Plasma Membrane
GNA12	guanine nucleotide binding protein (G protein) alpha 12	--		Plasma Membrane
GNRH2	gonadotropin-releasing hormone 2	--		Extracellular Space
GPI	glucose-6-phosphate isomerase	14751	14	Extracellular Space
GPM6B	glycoprotein M6B	--	16	Plasma Membrane
GPR98	G protein-coupled receptor 98	--		Plasma Membrane
GPR119	G protein-coupled receptor 119	--	17	Plasma Membrane
GRN	granulin	14824	14	Extracellular Space

H2-Q8	histocompatibility 2, Q region locus 8	15019	10	Plasma Membrane
H60a	histocompatibility 60a	--		Plasma Membrane
HFE	hemochromatosis	--		Plasma Membrane
HLA Class I	--	--	4	Plasma Membrane
HLA-B	major histocompatibility complex, class I, B	110558	10	Plasma Membrane
HLA-C	major histocompatibility complex, class I, C	14972	10	Plasma Membrane
HLA-DMA	major histocompatibility complex, class II, DM alpha	14998	4	Plasma Membrane
HLA-DMB	major histocompatibility complex, class II, DM beta	15000	4	Plasma Membrane
HLA-DOA	major histocompatibility complex, class II, DO alpha	--	12	Plasma Membrane
HLA-DQA1	major histocompatibility complex, class II, DQ alpha 1	14960	4	Plasma Membrane
HLA-DQB1	major histocompatibility complex, class II, DQ beta 1	14961	4	Plasma Membrane
HLA-DR	--	--	14	Plasma Membrane
HRAS	v-Ha-ras Harvey rat sarcoma viral oncogene homolog	--		Plasma Membrane
HRG	histidine-rich glycoprotein	--		Extracellular Space
Ifn	--	--	14	Extracellular Space
IFN alpha/beta	--	--	10	Extracellular Space
IFN Beta	--	--	14	Extracellular Space
Ifn gamma	--	--	14	Plasma Membrane
IFNA2	interferon, alpha 2	--		Extracellular Space
IFNG	interferon, gamma	--		Extracellular Space
Iga	--	--	5	Extracellular Space
IgD	--	--	5	Plasma Membrane
Ige	--	--	14	Extracellular Space
IGF1	insulin-like growth factor 1 (somatomedin C)	--		Extracellular Space
IGF1R	insulin-like growth factor 1 receptor	--		Plasma Membrane
IGFBP2	insulin-like growth factor binding protein 2, 36kDa	--	15	Extracellular Space
IgG	--	--	14	Extracellular Space
IGHA1	immunoglobulin heavy constant alpha 1	16061	16	Extracellular Space
Ighg	Immunoglobulin heavy chain (gamma polypeptide)	380794	4	Extracellular Space
IGHM	immunoglobulin heavy constant mu	16019	5	Plasma Membrane
IGJ	immunoglobulin J polypeptide, linker protein for immunoglobulin alpha and mu polypeptides	16069	5	Extracellular Space
IGKC	immunoglobulin kappa constant	--	12	Extracellular Space
Igm	--	--	5	Extracellular Space
IL1	--	--	14	Extracellular Space
IL2	interleukin 2	--		Extracellular Space
IL3	interleukin 3 (colony-stimulating factor, multiple)	--		Extracellular Space
IL3	interleukin 3	--		Extracellular Space
IL4	interleukin 4	--		Extracellular Space
IL5	interleukin 5 (colony-stimulating factor, eosinophil)	--		Extracellular Space
IL6	interleukin 6 (interferon, beta 2)	--	13	Extracellular Space
IL7	interleukin 7	--		Extracellular Space
IL15	interleukin 15	--		Extracellular Space
IL27	interleukin 27	--		Extracellular Space
IL12 (complex)	--	--	14	Extracellular Space
IL12 (family)	--	--	14	Extracellular Space
IL1B	interleukin 1, beta	--		Extracellular Space
IL2RG	interleukin 2 receptor, gamma	16186	5	Plasma Membrane
IL7R	interleukin 7 receptor	--		Plasma Membrane
immune complex	--	--	14	Extracellular Space
Ins1	insulin I	--		Extracellular Space
INS	insulin	--		Extracellular Space

INSR	insulin receptor	--		Plasma Membrane
Insulin	--	--	17	Extracellular Space
Integrin	--	--	11	Plasma Membrane
Interferon alpha	--	--	14	Extracellular Space
ITM2B	integral membrane protein 2B	16432	4	Plasma Membrane
KCNJ11	potassium inwardly-rectifying channel, subfamily J, member 11	--		Plasma Membrane
KIT	v-kit Hardy-Zuckerman 4 feline sarcoma viral oncogene homolog	--		Plasma Membrane
KITLG	KIT ligand	--		Extracellular Space
KLRC2	killer cell lectin-like receptor subfamily C, member 2	--		Plasma Membrane
Laminin	--	--	9	Extracellular Space
LDL	--	--	17	Plasma Membrane
LEP	leptin	--		Extracellular Space
Lh	--	--	17	Plasma Membrane
LTB	lymphotoxin beta (TNF superfamily, member 3)	16994	5	Extracellular Space
Ly6a (includes others)	lymphocyte antigen 6 complex, locus A	100041546	5	Plasma Membrane
LY6D	lymphocyte antigen 6 complex, locus D	17068	15	Plasma Membrane
LY6E	lymphocyte antigen 6 complex, locus E	17069	10	Plasma Membrane
MAGI2	membrane associated guanylate kinase, WW and PDZ domain containing 2	--		Plasma Membrane
MAL	mal, T-cell differentiation protein	--		Plasma Membrane
MAPT	microtubule-associated protein tau	--	16	Plasma Membrane
MHC	--	--	10	Plasma Membrane
MHC Class I (complex)	--	--	10	Plasma Membrane
MHC CLASS I (family)	--	--	14	Plasma Membrane
MHC Class II (complex)	--	--	4	Plasma Membrane
MHC I- α	--	--	10	Plasma Membrane
Mhc2 Alpha	--	--	4	Plasma Membrane
MIF	macrophage migration inhibitory factor (glycosylation-inhibiting factor)	17319	6	Extracellular Space
MMP23B	matrix metallopeptidase 23B	--	16	Extracellular Space
MS4A1	membrane-spanning 4-domains, subfamily A, member 1	12482	4	Plasma Membrane
MSN	moesin	17698	7	Plasma Membrane
MZB1	marginal zone B and B1 cell-specific protein	69816	10	Extracellular Space
NADPH oxidase	--	--	9	Plasma Membrane
NAPSA	napsin A aspartic peptidase	16541	1	Extracellular Space
NCR2	natural cytotoxicity triggering receptor 2	--		Plasma Membrane
Notch	--	--	2	Plasma Membrane
Pdgf (complex)	--	--	9	Extracellular Space
PDGF BB	--	--	11	Extracellular Space
PLAC1	placenta-specific 1	--	8	Plasma Membrane
PRL	prolactin	--		Extracellular Space
PSAP	prosaposin	19156	7	Extracellular Space
PSEN1	presenilin 1	--		Plasma Membrane
PTPRC	protein tyrosine phosphatase, receptor type, C	19264	10	Plasma Membrane
PTPRCAP	protein tyrosine phosphatase, receptor type, C-associated protein	--		Plasma Membrane
PTPRVP	protein tyrosine phosphatase, receptor type, V, pseudogene	--	17	Plasma Membrane
QRFP	pyroglutamylated RFamide peptide	--	17	Extracellular Space
Raet1a	retinoic acid early transcript 1, alpha	--		Plasma Membrane
Raet1b	retinoic acid early transcript beta	--		Plasma Membrane
Raet1d/Raet1e	retinoic acid early transcript 1E	--		Plasma Membrane
RASAL2	RAS protein activator like 2	--	17	Extracellular Space
RHCE/RHD	Rh blood group, D antigen	--		Plasma Membrane
RHO	rhodopsin	--		Plasma Membrane

RNASE6	ribonuclease, RNase A family, k6	78416	13	Extracellular Space
SDK1	sidekick cell adhesion molecule 1	--	8	Plasma Membrane
Secretase gamma	--	--	2	Plasma Membrane
SEMA4B	sema domain, immunoglobulin domain (Ig), transmembrane domain (TM) and short cytoplasmic domain, (semaphorin) 4B	--	12	Plasma Membrane
SLC12A6	solute carrier family 12 (potassium/chloride transporters), member 6	--		Plasma Membrane
SLC13A1	solute carrier family 13 (sodium/sulfate symporters), member 1	--		Plasma Membrane
SLC19A2	solute carrier family 19 (thiamine transporter), member 2	--	12	Plasma Membrane
SLC2A8	solute carrier family 2 (facilitated glucose transporter), member 8	--	17	Plasma Membrane
SLC5A5	solute carrier family 5 (sodium iodide symporter), member 5	--		Plasma Membrane
SLC9A3	solute carrier family 9, subfamily A (NHE3, cation proton antiporter 3), member 3	--		Plasma Membrane
SLIT3	slit homolog 3 (Drosophila)	--		Extracellular Space
SORT1	sortilin 1	--		Plasma Membrane
SPRED2	sprouty-related, EVH1 domain containing 2	--		Extracellular Space
TCR	--	--	9	Plasma Membrane
TECR	trans-2,3-enoyl-CoA reductase	106529	12	Plasma Membrane
Tgf beta	--	--	11	Extracellular Space
TGFA	transforming growth factor, alpha	--		Extracellular Space
TGFB1	transforming growth factor, beta 1	--		Extracellular Space
TLR9	toll-like receptor 9	--	13	Plasma Membrane
Tlr	--	--	14	Plasma Membrane
TMEM131	transmembrane protein 131	--	12	Extracellular Space
TNF	tumor necrosis factor	--		Extracellular Space
TNFRSF9	tumor necrosis factor receptor superfamily, member 9	--		Plasma Membrane
TNFRSF13C	tumor necrosis factor receptor superfamily, member 13C	72049	5	Plasma Membrane
TRPM1	transient receptor potential cation channel, subfamily M, member 1	--	17	Plasma Membrane
TSH	--	--	9	Plasma Membrane
TYROBP	TYRO protein tyrosine kinase binding protein	22177	10	Plasma Membrane
UTRN	utrophin	--		Plasma Membrane
Vegf	--	--	1	Extracellular Space
VEGFA	vascular endothelial growth factor A	--		Extracellular Space
VWF	von Willebrand factor	--		Extracellular Space
WNT1	wingless-type MMTV integration site family, member 1	--		Extracellular Space
WNT2B	wingless-type MMTV integration site family, member 2B	--	15	Extracellular Space
XPNPEP2	X-prolyl aminopeptidase (aminopeptidase P) 2, membrane-bound	--	13	Plasma Membrane
XPR1	xenotropic and polytropic retrovirus receptor 1	--	17	Plasma Membrane

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List of genes expressed in CD45dimVR1-CD31low cell population generated by R analyses

Rowname	Transcript_cluster_id	Entrezid	Symbol	Gene name
8	17210984	319263	Pcmt1	protein-L-isoaspartate (D-aspartate) O-methyltransferase domain containing 1
106	17212353	19944	Rpl29	ribosomal protein L29
176	17213580	55949	Eef1b2	eukaryotic translation elongation factor 1 beta 2
210	17214149	76709	Arpc2	actin related protein 2/3 complex, subunit 2
285	17215115	19231	Ptma	prothymosin alpha
411	17216834	19943	Rpl28	ribosomal protein L28
420	17216976	69169	Faim3	Fas apoptotic inhibitory molecule 3
516	17218254	67771	Arpc5	actin related protein 2/3 complex, subunit 5
637	17219581	21346	Tagln2	transgelin 2
816	17221871	17720	ND4L	NADH dehydrogenase subunit 4L
817	17221873	17706	ATP8	ATP synthase F0 subunit 8
818	17221873	100191075	Gm10925	predicted gene 10925
819	17221873	17705	ATP6	ATP synthase F0 subunit 6
1043	17225153	17975	Ncl	nucleolin
1143	17226420	74117	Actr3	ARP3 actin-related protein 3
1216	17227536	19264	Ptprc	protein tyrosine phosphatase, receptor type, C
1427	17230282	51810	Hnrnpu	heterogeneous nuclear ribonucleoprotein U
1644	17232892	53599	Cd164	CD164 antigen
1656	17233022	12484	Cd24a	CD24a antigen
1704	17233629	19156	Psap	prosaposin
1881	17235566	13629	Eef2	eukaryotic translation elongation factor 2
2167	17238226	17938	Naca	nascent polypeptide-associated complex alpha polypeptide
2344	17239744	20042	Rps12	ribosomal protein S12
2369	17240020	269261	Rpl12	ribosomal protein L12
2370	17240020	630855	LOC630855	60S ribosomal protein L12-like
2371	17240020	668706	Gm11425	predicted gene 11425
2427	17240595	67945	Rpl41	ribosomal protein L41
2429	17240606	12484	Cd24a	CD24a antigen

2469	17241228	13688 Eif4ebp2	eukaryotic translation initiation factor 4E binding protein 2
2527	17241962	17319 Mif	macrophage migration inhibitory factor
2608	17242839	66043 Atp5d	ATP synthase, H ⁺ transporting, mitochondrial F1 complex, delta subunit
2663	17243456	268449 Rpl23a	ribosomal protein L23A
2664	17243458	268449 Rpl23a	ribosomal protein L23A
2696	17243738	22027 Hsp90b1	heat shock protein 90, beta (Grp94), member 1
2799	17245223	17105 Lyz2	lysozyme 2
2805	17245302	215449 Rap1b	RAS related protein 1b
2970	17247140	268373 Ppia	peptidylprolyl isomerase A
2971	17247140	595139 E030024N20Rik	peptidylprolyl isomerase A pseudogene 8
3049	17248276	110257 Hba-a2	hemoglobin alpha, adult chain 2
3050	17248276	15122 Hba-a1	hemoglobin alpha, adult chain 1
3090	17248873	14694 Gnb2l1	guanine nucleotide binding protein (G protein), beta polypeptide 2 like 1
3177	17249801	14667 Gm2a	GM2 ganglioside activator protein
3437	17253108	22627 Ywhae	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, epsilon polypeptide
3580	17254827	100041294 Gm3258	predicted gene 3258
3581	17254827	20922 Supt4h1	suppressor of Ty 4 homolog 1 (S. cerevisiae)
3760	17256959	14824 Grn	granulin
3835	17258015	67671 Rpl38	ribosomal protein L38
3867	17258521	15078 H3f3a	H3 histone, family 3A
3868	17258521	667250 Gm12657	predicted gene 12657
3869	17258521	15081 H3f3b	H3 histone, family 3B
3870	17258521	625328 H3f3c	H3 histone, family 3C
3871	17258521	627371 Gm6749	predicted pseudogene 6749
4035	17260881	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
4125	17262174	14694 Gnb2l1	guanine nucleotide binding protein (G protein), beta polypeptide 2 like 1
4144	17262295	19946 Rpl30	ribosomal protein L30
4145	17262295	666899 Gm12191	ribosomal protein L30 pseudogene
4284	17264036	22187 Ubb	ubiquitin B
4362	17265126	56486 Gabarap	gamma-aminobutyric acid receptor associated protein
4368	17265186	52898 Rnasek	ribonuclease, RNase K
4377	17265319	18643 Pfn1	profilin 1
4465	17266362	268449 Rpl23a	ribosomal protein L23A
4466	17266362	100041478 Gm3362	predicted pseudogene 3362
4467	17266362	100043755 Gm10132	ribosomal protein L23A pseudogene
4837	17270837	15985 Cd79b	CD79B antigen
4845	17270974	100526469 Mir3064	microRNA 3064
4846	17270974	13207 Ddx5	DEAD (Asp-Glu-Ala-Asp) box polypeptide 5

5052	17274094	66480 Rpl15	ribosomal protein L15
5129	17275060	100628578 Mir5099	microRNA 5099
5267	17276893	20384 Srsf5	serine/arginine-rich splicing factor 5
5351	17277859	664969 Gm7429	predicted pseudogene 7429
5352	17277859	625281 Gm6570	predicted gene 6570
5353	17277859	619883 Gm6109	predicted gene 6109
5354	17277859	19946 Rpl30	ribosomal protein L30
5355	17277859	666899 Gm12191	ribosomal protein L30 pseudogene
5546	17279509	12925 Crip1	cysteine-rich protein 1 (intestinal)
5763	17282090	17187 Max	Max protein
5771	17282216	12192 Zfp3611	zinc finger protein 36, C3H type-like 1
5961	17284314	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
5962	17284314	16065 Igh-VS107	immunoglobulin heavy chain (S107 family)
5964	17284334	380794 Ighg	Immunoglobulin heavy chain (gamma polypeptide)
5966	17284349	16019 Ighm	immunoglobulin heavy constant mu
5967	17284354	629915 Ighv1-47	immunoglobulin heavy variable 1-47
5968	17284354	380795 Ighg3	Immunoglobulin heavy constant gamma 3
5969	17284354	195176 Igh-VX24	immunoglobulin heavy chain (X24 family)
5970	17284354	380794 Ighg	Immunoglobulin heavy chain (gamma polypeptide)
5971	17284354	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
5972	17284354	16019 Ighm	immunoglobulin heavy constant mu
5973	17284356	243420 Igkv1-135	immunoglobulin kappa variable 1-135
5974	17284356	380794 Ighg	Immunoglobulin heavy chain (gamma polypeptide)
5975	17284356	211331 Ighv1-54	immunoglobulin heavy variable V1-54
5976	17284356	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
5977	17284356	16019 Ighm	immunoglobulin heavy constant mu
5978	17284360	16019 Ighm	immunoglobulin heavy constant mu
5979	17284376	195176 Igh-VX24	immunoglobulin heavy chain (X24 family)
5996	17284577	780931 Ighv1-53	immunoglobulin heavy variable 1-53
5997	17284577	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
6000	17284605	16019 Ighm	immunoglobulin heavy constant mu
6001	17284607	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
6003	17284631	16061 Igh-VJ558	immunoglobulin heavy chain (J558 family)
6004	17284633	16019 Ighm	immunoglobulin heavy constant mu
6005	17284633	619916 Ighv1-72	immunoglobulin heavy variable 1-72
6006	17284648	16019 Ighm	immunoglobulin heavy constant mu
6092	17285691	319184 Hist1h2bk	histone cluster 1, H2bk
6093	17285691	319187 Hist1h2bn	histone cluster 1, H2bn

6094	17285691	319183	Hist1h2bj	histone cluster 1, H2bj
6095	17285691	68024	Hist1h2bc	histone cluster 1, H2bc
6096	17285691	319186	Hist1h2bm	histone cluster 1, H2bm
6097	17285691	319180	Hist1h2bf	histone cluster 1, H2bf
6098	17285691	319179	Hist1h2be	histone cluster 1, H2be
6099	17285691	319185	Hist1h2bl	histone cluster 1, H2bl
6100	17285691	319181	Hist1h2bg	histone cluster 1, H2bg
6101	17285691	665596	Hist1h2bq	histone cluster 1, H2bq
6102	17285691	319182	Hist1h2bh	histone cluster 1, H2bh
6103	17285691	665622	Hist1h2br	histone cluster 1 H2br
6425	17287891	15387	Hnrnpk	heterogeneous nuclear ribonucleoprotein K
6469	17288266	432768	Gm5451	predicted gene 5451
6509	17288650	434624	LOC434624	ferritin light chain 1-like
6510	17288650	14337	Ftl2	ferritin light chain 2
6511	17288650	100862446	LOC100862446	ferritin light chain 1-like
6512	17288650	14325	Ftl1	ferritin light chain 1
6515	17288695	751556	Mir682	microRNA 682
6516	17288695	19981	Rpl37a	ribosomal protein L37a
6612	17289787	20091	Rps3a	ribosomal protein S3A
6628	17290003	100190765	Mir449b	microRNA 449b
6636	17290074	623174	Gm6404	predicted gene 6404
6732	17290997	319187	Hist1h2bn	histone cluster 1, H2bn
6733	17290997	319183	Hist1h2bj	histone cluster 1, H2bj
6734	17290997	319180	Hist1h2bf	histone cluster 1, H2bf
6735	17290997	319185	Hist1h2bl	histone cluster 1, H2bl
7274	17295266	18824	Plp2	proteolipid protein 2
7275	17295270	59050	Nsa2	NSA2 ribosome biogenesis homolog (S. cerevisiae)
7335	17296170	67945	Rpl41	ribosomal protein L41
7958	17298791	100042634	Gm3940	ribosomal protein L23A pseudogene
7959	17298791	666738	Gm8264	predicted gene 8264
7960	17298791	666548	Gm8158	predicted gene 8158
7961	17298791	666501	Gm8137	predicted gene 8137
7962	17298791	100041478	Gm3362	predicted pseudogene 3362
7963	17298791	268449	Rpl23a	ribosomal protein L23A
7964	17298791	666448	Gm8112	predicted gene 8112
7965	17298791	100039571	Gm10335	ribosomal protein L23A pseudogene
7966	17298791	100043755	Gm10132	ribosomal protein L23A pseudogene
8017	17299247	218963	Gm1821	ubiquitin pseudogene

8018	17299247	22187 Ubb	ubiquitin B
8060	17299585	78416 Rnase6	ribonuclease, RNase A family, 6
8083	17299847	20085 Rps19	ribosomal protein S19
8091	17299924	20085 Rps19	ribosomal protein S19
8112	17300273	68836 Mrpl52	mitochondrial ribosomal protein L52
8264	17301968	18826 Lcp1	lymphocyte cytosolic protein 1
8313	17302578	67945 Rpl41	ribosomal protein L41
8747	17303472	623796 Gm12504	prothymosin alpha pseudogene
8748	17303472	19231 Ptma	prothymosin alpha
8990	17305986	85029 Rpph1	ribonuclease P RNA component H1
9206	17308603	16432 Itm2b	integral membrane protein 2B
9218	17308731	22070 Tpt1	tumor protein, translationally-controlled 1
9347	17310462	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
9348	17310462	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
9386	17311152	18285 Odf1	outer dense fiber of sperm tails 1
9456	17312050	19933 Rpl21	ribosomal protein L21
9472	17312209	17069 Ly6e	lymphocyte antigen 6 complex, locus E
9507	17312622	26961 Rpl8	ribosomal protein L8
9654	17314435	19817 Rn7sk	RNA, 7SK, nuclear
9678	17314679	22143 Tuba1b	tubulin, alpha 1B
9681	17314693	22146 Tuba1c	tubulin, alpha 1C
9709	17315045	23994 Dazap2	DAZ associated protein 2
9741	17315447	18521 Pcbp2	poly(rC) binding protein 2
9755	17315546	434858 Gm5643	heterogeneous nuclear ribonucleoprotein A1 pseudogene
9756	17315546	654467 Gm10052	heterogeneous nuclear ribonucleoprotein A1 pseudogene
9757	17315546	545091 Gm5803	predicted gene 5803
9758	17315546	15382 Hnrnpa1	heterogeneous nuclear ribonucleoprotein A1
9808	17316328	12465 Cct5	chaperonin containing Tcp1, subunit 5 (epsilon)
9888	17317327	211401 Mtss1	metastasis suppressor 1
9913	17317675	20442 St3gal1	ST3 beta-galactoside alpha-2,3-sialyltransferase 1
9940	17318020	17068 Ly6d	lymphocyte antigen 6 complex, locus D
9948	17318083	110454 Ly6a	lymphocyte antigen 6 complex, locus A
9950	17318100	100041546 Ly6c2	lymphocyte antigen 6 complex, locus C2
10018	17318967	100504034 Gm20024	predicted gene, 20024
10025	17319037	19354 Rac2	RAS-related C3 botulinum substrate 2
10078	17319588	72049 Tnfrsf13c	tumor necrosis factor receptor superfamily, member 13c
10095	17319770	73826 Poldip3	polymerase (DNA-directed), delta interacting protein 3
10150	17320607	665562 Rpl31-ps12	ribosomal protein L31, pseudogene 1 2

10151	17320607	114641 Rpl31	ribosomal protein L31
10216	17321481	22146 Tuba1c	tubulin, alpha 1C
10282	17322280	67942 Atp5g2	ATP synthase, H ⁺ transporting, mitochondrial F0 complex, subunit C2 (subunit 9)
10442	17324400	13682 Eif4a2	eukaryotic translation initiation factor 4A2
10578	17326166	16423 Cd47	CD47 antigen (Rh-related antigen, integrin-associated signal transducer)
10657	17326956	20655 Sod1	superoxide dismutase 1, soluble
10711	17327681	12914 Crebbp	CREB binding protein
10736	17328042	68142 Ino80	INO80 homolog (<i>S. cerevisiae</i>)
10737	17328042	57808 Rpl35a	ribosomal protein L35A
10812	17329023	16142 Iglv1	immunoglobulin lambda variable 1
11057	17331573	14109 Fau	Finkel-Biskis-Reilly murine sarcoma virus (FBR-MuSV) ubiquitously expressed (fox derived)
11313	17334129	75956 Srrm2	serine/arginine repetitive matrix 2
11415	17335330	19896 Rpl10a	ribosomal protein L10A
11491	17336407	14998 H2-DMa	histocompatibility 2, class II, locus DMa
11492	17336414	15000 H2-DMb2	histocompatibility 2, class II, locus Mb2
11498	17336494	14961 H2-Ab1	histocompatibility 2, class II antigen A, beta 1
11525	17336896	114584 Clic1	chloride intracellular channel 1
11535	17337024	16994 Ltb	lymphotoxin B
11546	17337120	15018 H2-Q7	histocompatibility 2, Q region locus 7
11547	17337120	68395 LOC68395	histocompatibility 2, Q region locus 6-like
11548	17337120	15019 H2-Q8	histocompatibility 2, Q region locus 8
11549	17337120	110558 H2-Q9	histocompatibility 2, Q region locus 9
11727	17338821	54217 Rpl36	ribosomal protein L36
11728	17338821	637553 LOC637553	60S ribosomal protein L36-like
11729	17338821	100043718 Gm4604	predicted gene 4604
11762	17339392	67268 Myl12a	myosin, light chain 12A, regulatory, non-sarcomeric
11775	17339554	77889 Lbh	limb-bud and heart
11851	17340500	67942 Atp5g2	ATP synthase, H ⁺ transporting, mitochondrial F0 complex, subunit C2 (subunit 9)
11853	17340522	434624 LOC434624	ferritin light chain 1-like
11854	17340522	14325 Ftl1	ferritin light chain 1
11855	17340522	14337 Ftl2	ferritin light chain 2
11856	17340522	100862446 LOC100862446	ferritin light chain 1-like
11937	17341240	100041965 Oaz1-ps	ornithine decarboxylase antizyme 1, pseudogene
11938	17341240	18245 Oaz1	ornithine decarboxylase antizyme 1
11959	17341356	171236 Vmn1r233	vomer nasal 1 receptor 233
12120	17343263	17691 Sik1	salt inducible kinase 1
12160	17343710	14972 H2-K1	histocompatibility 2, K1, K region
12169	17343789	16912 Psmb9	proteasome (prosome, macropain) subunit, beta type 9 (large multifunctional peptidase 2)

12171	17343813	14960 H2-Aa	histocompatibility 2, class II antigen A, alpha
12216	17344444	22154 Tubb5	tubulin, beta 5 class I
12308	17345186	15516 Hsp90ab1	heat shock protein 90 alpha (cytosolic), class B member 1
12496	17347680	12193 Zfp3612	zinc finger protein 36, C3H type-like 2
12513	17347938	12313 Calm1	calmodulin 1
12514	17347938	12314 Calm2	calmodulin 2
12515	17347938	12315 Calm3	calmodulin 3
12536	17348223	19942 Rpl27	ribosomal protein L27
12769	17350611	67804 Snx2	sorting nexin 2
12802	17350982	16149 Cd74	CD74 antigen (invariant polypeptide of major histocompatibility complex, class II antigen-associated)
12803	17350982	100628611 Mir5107	microRNA 5107
12876	17352020	11946 Atp5a1	ATP synthase, H ⁺ transporting, mitochondrial F1 complex, alpha subunit 1
12996	17353619	69816 2010001M09Rik	RIKEN cDNA 2010001M09 gene
13213	17356002	54445 Unc93b1	unc-93 homolog B1 (C. elegans)
13259	17356472	12631 Cfl1	cofilin 1, non-muscle
13268	17356556	72289 Malat1	metastasis associated lung adenocarcinoma transcript 1 (non-coding RNA)
13334	17357389	66395 Ahnak	AHNAK nucleoprotein (desmoyokin)
13336	17357418	14319 Fth1	ferritin heavy chain 1
13466	17358638	625917 Rpl31-ps20	ribosomal protein L31, pseudogene 20
13616	17360406	18569 Pcd4	programmed cell death 4
13617	17360406	100503572 Bbip1	BBSome interacting protein 1
13651	17360842	20042 Rps12	ribosomal protein S12
13672	17361073	14870 Gstp1	glutathione S-transferase, pi 1
13685	17361223	110355 Adrbk1	adrenergic receptor kinase, beta 1
13728	17361798	72289 Malat1	metastasis associated lung adenocarcinoma transcript 1 (non-coding RNA)
13772	17362330	20168 Rtn3	reticulon 3
13828	17362922	12482 Ms4a1	membrane-spanning 4-domains, subfamily A, member 1
13969	17364474	54132 Pdlim1	PDZ and LIM domain 1 (elfin)
13976	17364565	17060 Blnk	B cell linker
14010	17365098	20249 Scd1	stearoyl-Coenzyme A desaturase 1
14093	17366201	434484 Sp140	Sp140 nuclear body protein
14094	17366201	620078 C130026I21Rik	RIKEN cDNA C130026I21 gene
14095	17366201	381287 A530032D15Rik	RIKEN cDNA A530032D15Rik gene
14096	17366201	100041057 LOC100041057	nuclear body protein SP140-like
14097	17366201	100041708 LOC100041708	nuclear body protein SP140-like
14102	17366271	621875 A530040E14Rik	RIKEN cDNA A530040E14 gene
14103	17366271	109032 Sp110	Sp110 nuclear body protein
14330	17367055	22352 Vim	vimentin

14568	17370522	625054 Gm6548	eukaryotic translation elongation factor 1 alpha 1 pseudogene
14569	17370522	13627 Eef1a1	eukaryotic translation elongation factor 1 alpha 1
14977	17375373	12010 B2m	beta-2 microglobulin
15130	17377418	13010 Cst3	cystatin C
15226	17378596	70873 4921517L17Rik	RIKEN cDNA 4921517L17 gene
15365	17380366	67126 Atp5e	ATP synthase, H ⁺ transporting, mitochondrial F1 complex, epsilon subunit
15497	17380741	546663 Gm5963	predicted pseudogene 5963
15498	17380741	66481 Rps21	ribosomal protein S21
15887	17386692	20104 Rps6	ribosomal protein S6
16272	17390596	242408 4930412F15Rik	RIKEN cDNA 4930412F15 gene
16273	17390596	378702 Serf2	small EDRK-rich factor 2
16492	17393501	170791 Rbm39	RNA binding motif protein 39
16505	17393658	56045 Samhd1	SAM domain and HD domain, 1
16538	17394047	26943 Serinc3	serine incorporator 3
16634	17395165	67126 Atp5e	ATP synthase, H ⁺ transporting, mitochondrial F1 complex, epsilon subunit
16793	17396162	12349 Car2	carbonic anhydrase 2
16812	17396336	241621 Gm13981	predicted gene 13981
16813	17396336	26451 Rpl27a	ribosomal protein L27A
16814	17396336	100505355 LOC100505355	60S ribosomal protein L27a-like
16916	17397825	270106 Rpl13	ribosomal protein L13
16917	17397825	100040416 Gm10071	predicted gene 10071
16927	17397936	56758 Mbnl1	muscleblind-like 1 (Drosophila)
17002	17398970	17261 Mef2d	myocyte enhancer factor 2D
17065	17399812	20200 S100a6	S100 calcium binding protein A6 (calcyclin)
17092	17399904	22631 Ywhaz	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, zeta polypeptide
17107	17399995	20195 S100a11	S100 calcium binding protein A11 (calgizzarin)
17108	17400000	20194 S100a10	S100 calcium binding protein A10 (calpactin)
17138	17400375	13040 Ctss	cathepsin S
17142	17400418	17210 Mcl1	myeloid cell leukemia sequence 1
17153	17400545	319176 Hist2h2ac	histone cluster 2, H2ac
17154	17400545	319192 Hist2h2aa2	histone cluster 2, H2aa2
17155	17400545	15267 Hist2h2aa1	histone cluster 2, H2aa1
17188	17400599	56338 Txnip	thioredoxin interacting protein
17226	17401094	229663 Csde1	cold shock domain containing E1, RNA binding
17351	17402604	668706 Gm11425	predicted gene 11425
17352	17402604	630855 LOC630855	60S ribosomal protein L12-like
17353	17402604	269261 Rpl12	ribosomal protein L12
17404	17403314	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene

17405	17403314	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
17813	17407631	19172 Psmb4	proteasome (prosome, macropain) subunit, beta type 4
17832	17407826	17210 Mcl1	myeloid cell leukemia sequence 1
17858	17408017	319176 Hist2h2ac	histone cluster 2, H2ac
17859	17408017	319192 Hist2h2aa2	histone cluster 2, H2aa2
17860	17408017	15267 Hist2h2aa1	histone cluster 2, H2aa1
17915	17408497	12481 Cd2	CD2 antigen
17926	17408662	15257 Hipk1	homeodomain interacting protein kinase 1
17951	17408960	12508 Cd53	CD53 antigen
17981	17409376	100217438 Scarna2	small Cajal body-specific RNA 2
18090	17410581	242248 Bank1	B cell scaffold protein with ankyrin repeats 1
18133	17411141	16785 Rpsa	ribosomal protein SA
18390	17413211	269523 Vcp	valosin containing protein
18439	17414007	98758 Hnrnpf	heterogeneous nuclear ribonucleoprotein F
18724	17416160	622167 LOC622167	uncharacterized LOC622167
18888	17418483	434624 LOC434624	ferritin light chain 1-like
18889	17418483	14325 Ftl1	ferritin light chain 1
18890	17418483	14337 Ftl2	ferritin light chain 2
18891	17418483	100862446 LOC100862446	ferritin light chain 1-like
19251	17423006	75620 2810422J05Rik	RIKEN cDNA 2810422J05 gene
19252	17423006	22186 Uba52	ubiquitin A-52 residue ribosomal protein fusion product 1
19475	17425276	11702 Amd1	S-adenosylmethionine decarboxylase 1
19476	17425276	100041585 Amd2	S-adenosylmethionine decarboxylase 2
19516	17425836	230257 Rod1	ROD1 regulator of differentiation 1 (S. pombe)
19851	17427183	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
19852	17427183	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
20102	17430436	54709 Eif3i	eukaryotic translation initiation factor 3, subunit I
20162	17431174	23833 Cd52	CD52 antigen
20163	17431181	73723 Sh3bgrl3	SH3 domain binding glutamic acid-rich protein-like 3
20201	17431672	12540 Cdc42	cell division cycle 42
20507	17434295	19941 Rpl26	ribosomal protein L26
20508	17434295	100034726 Gm15772	ribosomal protein L26 pseudogene
20649	17436077	192292 Nrbp1	nuclear receptor binding protein 1
21104	17439361	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
21206	17440754	54127 Rps28	ribosomal protein S28
21276	17441949	11669 Aldh2	aldehyde dehydrogenase 2, mitochondrial
21908	17449447	16069 Igj	immunoglobulin joining chain
21921	17449647	270106 Rpl13	ribosomal protein L13

21983	17450121	231507 Plac8	placenta-specific 8
22012	17450532	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
22013	17450532	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
22030	17450741	11958 Atp5k	ATP synthase, H ⁺ transporting, mitochondrial F1F0 complex, subunit e
22107	17451726	12861 Cox6a1	cytochrome c oxidase, subunit VI a, polypeptide 1
22203	17453102	100862433 LOC100862433	40S ribosomal protein S16-like
22204	17453102	100505015 LOC100505015	40S ribosomal protein S16-like
22205	17453102	20055 Rps16	ribosomal protein S16
22206	17453102	100039355 Rps16-ps2	ribosomal protein S16, pseudogene 2
22211	17453137	12466 Cct6a	chaperonin containing Tcp1, subunit 6a (zeta)
22841	17459276	66870 Serbp1	serpine1 mRNA binding protein 1
22842	17459294	628027 Igkv1-133	immunoglobulin kappa variable 1-133
22843	17459324	434025 Igkv9-120	immunoglobulin kappa chain variable 9-120
22844	17459324	16081 Igk-V1	immunoglobulin kappa chain variable 1 (V1)
22845	17459347	692169 Igkv15-103	immunoglobulin kappa chain variable 15-103
22846	17459415	385120 Igkv4-70	immunoglobulin kappa chain variable 4-70
22847	17459415	243431 Igkv9-124	immunoglobulin kappa chain variable 9-124
22848	17459415	16114 Igk-V28	immunoglobulin kappa chain variable 28 (V28)
22849	17459421	381783 Igkv5-43	immunoglobulin kappa chain variable 5-43
22850	17459423	546213 Igkv4-53	immunoglobulin kappa variable 4-53
22851	17459423	110759 Igkj1	immunoglobulin kappa joining 1
22852	17459423	16114 Igk-V28	immunoglobulin kappa chain variable 28 (V28)
22853	17459423	637227 Igkv6-23	immunoglobulin kappa variable 6-23
22856	17459453	68436 Rpl34	ribosomal protein L34
22857	17459453	619547 Rpl34-ps1	ribosomal protein L34, pseudogene 1
23374	17465830	14489 Mtpn	myotrophin
23519	17467308	100862455 LOC100862455	60S ribosomal protein L23-like
23520	17467308	100044627 LOC100044627	60S ribosomal protein L23-like
23521	17467308	65019 Rpl23	ribosomal protein L23
23530	17467389	110759 Igkj1	immunoglobulin kappa joining 1
23531	17467398	434033 Igkv4-91	immunoglobulin kappa chain variable 4-91
23532	17467430	385109 Igkv4-72	immunoglobulin kappa chain variable 4-72
23533	17467435	385120 Igkv4-70	immunoglobulin kappa chain variable 4-70
23536	17467480	16114 Igk-V28	immunoglobulin kappa chain variable 28 (V28)
23538	17467489	381783 Igkv5-43	immunoglobulin kappa chain variable 5-43
23542	17467540	16114 Igk-V28	immunoglobulin kappa chain variable 28 (V28)
23606	17468273	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
23607	17468273	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase

23703	17469414	108655	Foxp1	forkhead box P1
23742	17469936	19951	Rpl32	ribosomal protein L32
23751	17470060	213391	Rassf4	Ras association (RalGDS/AF-6) domain family member 4
23906	17471867	56449	Csda	cold shock domain protein A
24025	17473234	76846	Rps9	ribosomal protein S9
24111	17473796	20103	Rps5	ribosomal protein S5
24538	17475127	12518	Cd79a	CD79A antigen (immunoglobulin-associated alpha)
24646	17476364	22177	Tyrbp	TYRO protein tyrosine kinase binding protein
24775	17477508	16541	Napsa	napsin A aspartic peptidase
24793	17477695	210172	Zfp526	zinc finger protein 526
24806	17477832	434624	LOC434624	ferritin light chain 1-like
24807	17477832	14325	Ftl1	ferritin light chain 1
24808	17477832	100862446	LOC100862446	ferritin light chain 1-like
24851	17478474	654472	Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
24852	17478474	14433	Gapdh	glyceraldehyde-3-phosphate dehydrogenase
24961	17479892	15387	Hnrnpk	heterogeneous nuclear ribonucleoprotein K
25094	17481232	15130	Hbb-b2	hemoglobin, beta adult minor chain
25095	17481232	15129	Hbb-b1	hemoglobin, beta adult major chain
25096	17481232	100503605	Beta-s	hemoglobin subunit beta-1-like
25178	17481640	66085	Eif3f	eukaryotic translation initiation factor 3, subunit F
25433	17485226	16985	Lsp1	lymphocyte specific 1
25438	17485297	12520	Cd81	CD81 antigen
25459	17485586	76846	Rps9	ribosomal protein S9
25715	17486581	20103	Rps5	ribosomal protein S5
25741	17486781	20364	Sepw1	selenoprotein W, muscle 1
26506	17488458	22695	Zfp36	zinc finger protein 36
26569	17489320	12483	Cd22	CD22 antigen
26608	17489620	14751	Gpi1	glucose phosphate isomerase 1
26677	17490274	272382	Spib	Spi-B transcription factor (Spi-1/PU.1 related)
26712	17490702	12493	Cd37	CD37 antigen
26902	17492239	100504230	AU020206	expressed sequence AU020206
26931	17492661	29875	Iqgap1	IQ motif containing GTPase activating protein 1
26979	17493182	68052	Rps13	ribosomal protein S13
27020	17493668	27050	Rps3	ribosomal protein S3
27095	17494221	15130	Hbb-b2	hemoglobin, beta adult minor chain
27096	17494221	15129	Hbb-b1	hemoglobin, beta adult major chain
27097	17494221	100503605	Beta-s	hemoglobin subunit beta-1-like
27316	17496146	19933	Rpl21	ribosomal protein L21

27320	17496193	12478 Cd19	CD19 antigen
27333	17496376	12721 Coro1a	coronin, actin binding protein 1A
27402	17497055	27176 Rpl7a	ribosomal protein L7A
27620	17499620	19921 Rpl19	ribosomal protein L19
28194	17506067	68196 Hsbp1	heat shock factor binding protein 1
28208	17506273	12857 Cox4i1	cytochrome c oxidase subunit IV isoform 1
28536	17509899	67184 Ndufa13	NADH dehydrogenase (ubiquinone) 1 alpha subcomplex, 13
28556	17510127	16478 Jun	Jun proto-oncogene related gene d
28558	17510136	65972 Ifi30	interferon gamma inducible protein 30
28621	17510906	106529 Tecr	trans-2,3-enoyl-CoA reductase
28624	17510948	26364 Cd97	CD97 antigen
28625	17510948	68278 Ddx39	DEAD (Asp-Glu-Ala-Asp) box polypeptide 39
28682	17511639	654472 Gm12070	glyceraldehyde-3-phosphate dehydrogenase pseudogene
28683	17511639	14433 Gapdh	glyceraldehyde-3-phosphate dehydrogenase
28743	17512474	667846 Gm8841	predicted gene 8841
28770	17512752	27370 Rps26	ribosomal protein S26
28771	17512752	100046297 LOC100046297	40S ribosomal protein S26-like
28860	17513856	270106 Rpl13	ribosomal protein L13
28886	17514243	270110 Irf2bp2	interferon regulatory factor 2 binding protein 2
28936	17514832	75316 Taf1d	TATA box binding protein (Tbp)-associated factor, RNA polymerase I, D
29140	17516365	15481 Hspa8	heat shock protein 8
29219	17517209	18985 Pou2af1	POU domain, class 2, associating factor 1
29308	17518298	67891 Rpl4	ribosomal protein L4
29334	17518664	19035 Ppib	peptidylprolyl isomerase B
29406	17519734	100503203 Gm19592	predicted gene, 19592
29417	17519895	78294 Rps27a	ribosomal protein S27A
29422	17519954	27176 Rpl7a	ribosomal protein L7A
29460	17520588	268373 Ppia	peptidylprolyl isomerase A
29461	17520588	595139 E030024N20Rik	peptidylprolyl isomerase A pseudogene 8
29556	17521673	11848 Rhoa	ras homolog gene family, member A
29557	17521681	14775 Gpx1	glutathione peroxidase 1
29625	17522803	100862039 LOC100862039	uncharacterized LOC100862039
29653	17523244	67115 Rpl14	ribosomal protein L14
29798	17525073	67945 Rpl41	ribosomal protein L41
29816	17525310	14247 Fli1	Friend leukemia integration 1
29822	17525391	434394 Gm5614	ribosomal protein L36 pseudogene
29929	17526421	27425 Atp5f1	ATP synthase, H ⁺ transporting, mitochondrial F0 complex, subunit g
29962	17526805	434434 Gm5621	predicted gene 5621

29963	17526805	110954 Rpl10	ribosomal protein L10
29983	17526988	69809 1810046K07Rik	RIKEN cDNA 1810046K07 gene
30055	17527927	56040 Rplp1	ribosomal protein, large, P1
30144	17529001	19817 Rn7sk	RNA, 7SK, nuclear
30293	17531181	11848 Rhoa	ras homolog gene family, member A
30353	17531954	100043813 Gm9846	predicted gene 9846
30354	17531954	57294 Rps27	ribosomal protein S27
30401	17532524	654467 Gm10052	heterogeneous nuclear ribonucleoprotein A1 pseudogene
30402	17532524	545091 Gm5803	predicted gene 5803
30403	17532524	15382 Hnrnpa1	heterogeneous nuclear ribonucleoprotein A1
30411	17532603	17716 ND1	NADH dehydrogenase subunit 1
30412	17532607	17717 ND2	NADH dehydrogenase subunit 2
30413	17532609	17708 COX1	cytochrome c oxidase subunit I
30414	17532613	18646 Prf1	perforin 1 (pore forming protein)
30415	17532613	17709 COX2	cytochrome c oxidase subunit II
30416	17532617	17710 COX3	cytochrome c oxidase subunit III
30417	17532621	17718 ND3	NADH dehydrogenase subunit 3
30418	17532625	17719 ND4	NADH dehydrogenase subunit 4
30419	17532631	17721 ND5	NADH dehydrogenase subunit 5
30420	17532633	17711 CYTB	cytochrome b
30421	17532649	17722 ND6	NADH dehydrogenase subunit 6
30908	17534139	100503795 Gm19899	predicted gene, 19899
31240	17536364	17698 Msn	moesin
31263	17536665	100503548 Gm19763	predicted gene, 19763
31604	17539649	100503054 Gm19528	predicted gene, 19528
32513	17543572	16186 Il2rg	interleukin 2 receptor, gamma chain
32518	17543654	20102 Rps4x	ribosomal protein S4, X-linked
32578	17544333	20042 Rps12	ribosomal protein S12
32579	17544335	20042 Rps12	ribosomal protein S12
32580	17544337	20042 Rps12	ribosomal protein S12
32581	17544339	20042 Rps12	ribosomal protein S12
32582	17544341	20042 Rps12	ribosomal protein S12
32583	17544343	20042 Rps12	ribosomal protein S12
32743	17546093	19241 Tmsb4x	thymosin, beta 4, X chromosome
33185	17546774	170942 Erdr1	erythroid differentiation regulator 1
33723	17547521	20088 Rps24	ribosomal protein S24
33724	17547521	677113 LOC677113	40S ribosomal protein S24-like
33748	17547573	19989 Rpl7	ribosomal protein L7

33766	17547608	11465 Actg1	actin, gamma, cytoplasmic 1
33771	17547620	434624 LOC434624	ferritin light chain 1-like
33772	17547620	100862446 LOC100862446	ferritin light chain 1-like
33773	17547620	14325 Ftl1	ferritin light chain 1
33774	17547620	14337 Ftl2	ferritin light chain 2
33816	17547698	12864 Cox6c	cytochrome c oxidase, subunit VIc
33817	17547698	621837 Gm6265	predicted pseudogene 6265
33832	17547728	13627 Eef1a1	eukaryotic translation elongation factor 1 alpha 1
33855	17547769	20084 Rps18	ribosomal protein S18
33860	17547781	100861617 LOC100861617	uncharacterized LOC100861617
33861	17547781	67511 Tmed9	transmembrane emp24 protein transport domain containing 9
33912	17547869	22631 Ywhaz	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, zeta polypeptide
33913	17547869	100505062 LOC100505062	uncharacterized LOC100505062
33937	17547917	100862258 LOC100862258	high mobility group protein B1-like
33938	17547917	637733 LOC637733	high mobility group protein B1-like
33939	17547917	619937 Gm6115	predicted gene 6115
33940	17547917	15289 Hmgb1	high mobility group box 1
33984	17547998	19326 Rab11b	RAB11B, member RAS oncogene family
33985	17548000	22154 Tubb5	tubulin, beta 5 class I
34001	17548030	53817 Ddx39b	DEAD (Asp-Glu-Ala-Asp) box polypeptide 39B
34002	17548030	100862184 LOC100862184	uncharacterized LOC100862184
34011	17548049	93722 Pcdhga10	protocadherin gamma subfamily A, 10
34012	17548049	100503571 Gm19774	predicted gene, 19774
34081	17548182	100862033 LOC100862033	uncharacterized LOC100862033
34086	17548193	100862060 LOC100862060	uncharacterized LOC100862060
34087	17548193	22352 Vim	vimentin
34101	17548217	100862258 LOC100862258	high mobility group protein B1-like
34102	17548217	637733 LOC637733	high mobility group protein B1-like
34103	17548217	619937 Gm6115	predicted gene 6115
34104	17548217	15289 Hmgb1	high mobility group box 1
34138	17548283	15081 H3f3b	H3 histone, family 3B
34139	17548283	667250 Gm12657	predicted gene 12657
34140	17548283	625328 H3f3c	H3 histone, family 3C
34141	17548283	627371 Gm6749	predicted pseudogene 6749
34142	17548283	15078 H3f3a	H3 histone, family 3A
34160	17548324	67628 Anp32b	acidic (leucine-rich) nuclear phosphoprotein 32 family, member B
34176	17548348	11465 Actg1	actin, gamma, cytoplasmic 1
34179	17548352	100040110 Gm12739	predicted gene 12739

34199	17548379	15481 Hspa8	heat shock protein 8
34222	17548426	22628 Ywhag	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, gamma polypeptide
34233	17548444	67695 Ost4	oligosaccharyltransferase 4 homolog (<i>S. cerevisiae</i>)
34255	17548488	100862258 LOC100862258	high mobility group protein B1-like
34256	17548488	637733 LOC637733	high mobility group protein B1-like
34257	17548488	619937 Gm6115	predicted gene 6115
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34311	17548597	100505014 LOC100505014	60S ribosomal protein L15-like
34363	17548654	66489 Rpl35	ribosomal protein L35
34377	17548681	18103 Nme2	NME/NM23 nucleoside diphosphate kinase 2
34378	17548681	114873 Dscaml1	Down syndrome cell adhesion molecule like 1
34390	17548703	15900 Irf8	interferon regulatory factor 8
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34427	17548777	20918 Eif1	eukaryotic translation initiation factor 1
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34521	17548946	667250 Gm12657	predicted gene 12657
34522	17548946	625328 H3f3c	H3 histone, family 3C
34523	17548946	627371 Gm6749	predicted pseudogene 6749
34524	17548946	15078 H3f3a	H3 histone, family 3A
34550	17548998	21346 Tagln2	transgelin 2

Supplemental Material

An immature B-cell population from peripheral blood serves as surrogate marker for monitoring tumor angiogenesis and anti-angiogenic therapy in mouse models

Ernesta Fagiani, Ruben Bill, Laura Pisarsky, Robert Ivanek, Curzio Rüegg, and Gerhard Christofori

Supplementary Figure Legends

Supplementary Figure 1. Experimental scheme of the flow cytometry analysis and the combinations of surface marker expression tested on PBMNCs by flow cytometry.

(A) The scheme summarizes the flow cytometry experimental protocol: blood was collected by heart puncture from different mouse models as indicated, PBMNCs were purified by Ficoll gradient and, finally, a multitude of surface markers and combination thereof were tested by flow cytometry. The criteria to identify cell populations that potentially could represent surrogate markers for tumor angiogenesis were: 1. The levels of a defined cell population should be higher in the peripheral blood of tumor bearing-mice as compared to tumor-free control mice; 2. The increased levels of the cell population in tumor-bearing mice should be reduced upon anti-angiogenic treatments.

(B) The table summarizes the combinations of surface markers that are known to define certain subsets of bone marrow-derived cells and that have been tested on PBMNCs purified from peripheral blood of tumor-free C57Bl/6 mice and tumor-bearing transgenic RT2 mice.

Supplementary Figure 2. Levels of $CD45^{dim}VR1^{-}$, $CD45^{dim}VR1^{-}CD31^{low}$ and $TIE2^{+}VR2^{+}VR1^{-}$ cell populations are significantly larger in peripheral blood of 8-9-week old RT2, 10-week MMTV-PyMT and of syngeneic TRAMPC1-transplanted C57Bl/6 tumor mice compared to healthy mice.

(A) Quantification of the CD45^{dim}VR1⁻, CD45^{dim}VR1⁻CD31^{low} and TIE2⁺VR2⁺VR1⁻ and TEM cell populations in peripheral blood of 10-week old MMTV-PyMT (N=7) in comparison to FVB/N (N=5-6) healthy mice.

(B) Quantification of CD45^{dim}VR1⁻ and CD45^{dim}VR1⁻CD31^{low} cells in the peripheral blood of C57Bl/6 mice transplanted with syngeneic TRAMPC1 prostate cancer cells C57Bl/6 (N=6) in comparison to non-transplanted C57Bl/6 control mice (N=3).

(C) Quantification of CD45^{dim}VR1⁻ and CD45^{dim}VR1⁻CD31^{low} cells in the peripheral blood of RT2 at 8-9-weeks of age (N=10) in comparison to wildtype C57Bl/6 mice (N=7).

Mann-Whitney test: *, P<0.05, **, P<0.01; ***, P<0.005.

Supplementary Figure 3. Tumor growth and tumor microvessel densities are significantly reduced in tumor-bearing mice after short-term anti-angiogenic therapy.

(A) Representative immunofluorescence images of CD31 (red) staining of histological sections of RT2 tumors after 5 days of PTK/ZK (N=6, n=41) or PEG-300 (N=6, n=41) treatment. DAPI (blue) is used to visualize nuclei. Scale bar, 100µm. The quantification of tumor volumes and tumor microvessel densities is shown below.

(B) Quantification of tumor volumes and tumor microvessel densities tumors of tumors of MMTV-PyMT transgenic mice after 5 days of treatment with PTK/ZK (N=3, n=35) or PEG-300 (N=4, n=49).

(C) Quantification of tumor volumes and tumor microvessel densities of tumors in RT2 mice after 5 days of sunitinib (N=5, n=43) or vehicle treatment (N=5, n=49).

N=number of mice, n=number of microscopic fields analyzed. Mann-Whitney test: **, P<0.01; ***, P<0.005; ****, P<0.001.

Supplementary Figure 4. Tumor growth and tumor microvessel densities are significantly reduced in tumor-bearing mice after long-term anti-angiogenic therapies.

(A) Representative immunofluorescence images of CD31 (red) staining on histological sections of RT2 tumors after ten days of PTK/ZK or PEG-300 treatment. DAPI (blue) is used to visualize nuclei. Scale bar, 100µm. Quantification of tumor volumes and tumor microvessel densities after ten days of treatment with PTK/ZK (N=5) or PEG-300 (N=5) is shown below.

(B) Quantitative reverse transcription (RT) PCR of tumors of RT2 mice treated for five or ten days with PTK/ZK or PEG-300. The mRNA levels of *Vegfr1*, *Vegfr2*, *Vegfr3*, *Nrp1*, *Nrp2*, *Cd31*, *Fgf1*, *Fgf2*, *Vegf-a* and *Hif1 α* genes in tumors of PTK/ZK-treated RT2 mice are normalized to the expression levels of RPL19 in the respective tumors. Each bar represents cDNA pooled from tumors of five different mice.

(C) Quantifications of tumor volumes and tumor microvessel densities in RT2 transgenic mice upon ten days of PTK/ZK treatment followed by two weeks of treatment with recombinant adenovirus expressing soluble FGFR (N=6) or GFP as control (N=6). Injections of adenovirus were performed once a week.

N=number of mice, every data point in the measurements of microvessel densities represents one microscopic field analyzed. Mann-Whitney test: *, P<0.05; ****, P<0.001.

Supplementary Figure 5. Islet microvessel densities are not affected by short-term or long-term anti-angiogenic therapies in wildtype C57Bl/6 mice.

(A-C) Quantification of the microvessel densities in islets of Langerhans in tumor-free C57Bl/6 mice after 5 days of treatment with PTK/ZK (N=2, n=21) or PEG-300 (N=4, n=11), treatment for 5 days with BIBF-1120 (nintedanib; N=4, n=17) or 0.5% Natrosol (N=5, n=20), and 3 weeks of treatment with BIBF-1120 (nintedanib; N=7, n=26) or 0.5% Natrosol (N=6, n=16). N=number of mice, n=number of microscopic fields analyzed.

Supplementary Figure 6. Schematic representation of B cell ontogeny and classification of CD45^{dim}VR1⁻CD31^{low} cells as an immature B cell population.

(A) The schematic figure depicts a summary of the markers that describe B cell development in bone marrow and their maturation in spleen and in blood. The red square highlights the markers expressed by CD45^{dim}VR1⁻CD31^{low} cells defining them as an immature B cell population. HCS, Hematopoietic Stem Cell; LT-HCS, Long-Term Hematopoietic Stem Cell; ELP, Early Lymphoid Progenitor; NF-B, Newly Formed B cell; T1, Transitional T1; T2, Transitional T2; Tr B, Transitional B cell; FO/B2, Follicular B cell; MZ B, Marginal Zone B cell.

(B) Representative flow cytometry analysis showing the percentage of CD45^{dim}VR1⁻CD31^{low} cells negative for CD21 (99%) or negative for CD23 (93%).

(C) Representative flow cytometry analysis highlighting that CD45^{dim}VR1⁻CD31^{low} cells are positive for IgM expression but lack expression of IgD and CD21. All these analyses were performed using peripheral blood from 12-week old RT2 mice.

Supplementary Figure 7. CD45^{dim}VR1⁻CD31^{low} immature B cells are localized within tumors of RT2 mice, although at low frequency.

(A) Immunofluorescence staining of histological sections of RT2 tumors for the expression of markers of B cell development. In the upper panels white arrows indicate positive cells for CD19 (green) and IgM (orange). In the lower panels white arrows indicate cells that are positive for CD45^{dim} (violet), negative for IgD (green) and positive for IgM (red). Scale bars, 20µm.

(B) Quantification of the CD45^{dim}VR1⁻CD31^{low}IgM⁺IgD⁻ cell population by flow cytometry in bone marrow, blood, spleen, lymph nodes (LN) and tumors of 12-week old RT2 mice (number of experiments=3, number of mice=6). The levels of the cell population are displayed as percentage of living singlet cells.

Supplementary Figure 8. The levels of CD45^{dim}VR1⁻CD31^{low} immature B cells are not increased in tumor-bearing immunodeficient mice.

(A) Shown are representative flow cytometry analyses of CD45^{dim}VR1⁻CD31^{low} cells circulating in the peripheral blood of immunodeficient Rag2^{-/-}/γc^{-/-} (Rag2) mice and in Rag2 mice previously transplanted with MTF1ECad tumor cells. Some of the transplanted mice developed mammary tumors (Rag2 tum) and some did not (Rag2 no tum)[47].

(B) The levels of the cell population are displayed as percentage of living singlet cells. Rag2 = 0.111%; Rag2 no tum = 0.125%; Rag2 tum = 0.114%.

Supplementary Figure 9. The levels of CD45^{dim}VR1⁻CD31^{low} immature B cells are not significantly increased in the peripheral blood of Rip1VEGF-E transgenic mice, a model of increased angiogenesis in normal pancreatic islets of Langerhans.

(A) Shown are a schematic representation of the Rip1VEGF-E transgene and exemplary co-immunofluorescence staining of histological sections of islets of

Lnagerhans from transgenic Rip1VEGF-E mice and from non-transgenic mice for CD31 (red) and insulin (green) expression. DAPI (blue) is used to visualize nuclei. Size bar, 100µm.

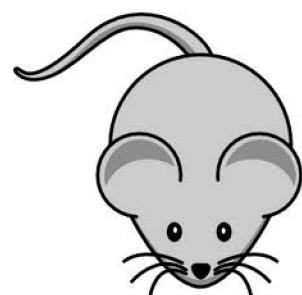
(B) Quantification of the CD45^{dim}VR1⁻CD31^{low}IgM⁺IgD⁻ cell population in the peripheral blood of 12-week old Rip1VEGF-E and of non-transgenic C57BL/6 mice by flow cytometry. The levels of the cell population are displayed as percentage of living singlet cells.

Primer sequences for RT-PCR

GENE	SEQUENCE
<i>Vegfr1</i>	Fw 5' aagacggttagcacattggtgg 3' Rev 5' aaagccattcggcacatctgt 3'
<i>Vegfr2</i>	Fw 5' agctcatcatcctagagcgcac 3' Rev 5' cgccaatggttgttctga 3'
<i>Vegfr3</i>	Fw 5' cgtgtgtgaagtgcaggatagg 3' Rev 5' tcactcacgttcaccaggaggt 3'
<i>Nrp1</i>	Fw 5' cccggaggaatgttctgtc 3' Rev 5' ccaatgtgagggccaactt 3'
<i>Nrp2</i>	Fw 5' atggctggacaccaattt 3' Rev 5' atggttaggaagcgcaggt 3'
<i>Cd31</i>	Fw 5' cgggttcagcgagatcc 3' Rev 5' cgacaggatggaatcaca 3'
<i>Fgf1</i>	Fw 5' ccgaagggttttatacgg 3' Rev 5' tcttgaggtgtaagtgtataatgg 3'
<i>Fgf2</i>	Fw 5' cggcttactgcaagaacg 3' Rev 5' tgcttgaggtgtagttgacg 3'

<i>Vegf-a</i>	Fw 5' actggaccctggcttactg 3' Rev 5' tctgctctccttctgtcgtg 3'
<i>Hif1a</i>	Fw 5' gcactagacaaagttcacctgaga 3' Rev 5' cgctatccacatcaaagcaa 3'
<i>Rpl19</i>	Fw 5' tcatccaggtcaccttctca 3' Rev 5' ctcgttgccgaaaaaca 3'

A



C57BL/6
FVB/N
RT2
MMTV-PyMT
TRAMPC1 in C57BL/6
Py2T in FVB
4T1 in BALB/c



Blood withdrawal by heart puncture



PBMNCs purification by Ficoll gradient



Test surface marker combinations by flow cytometry

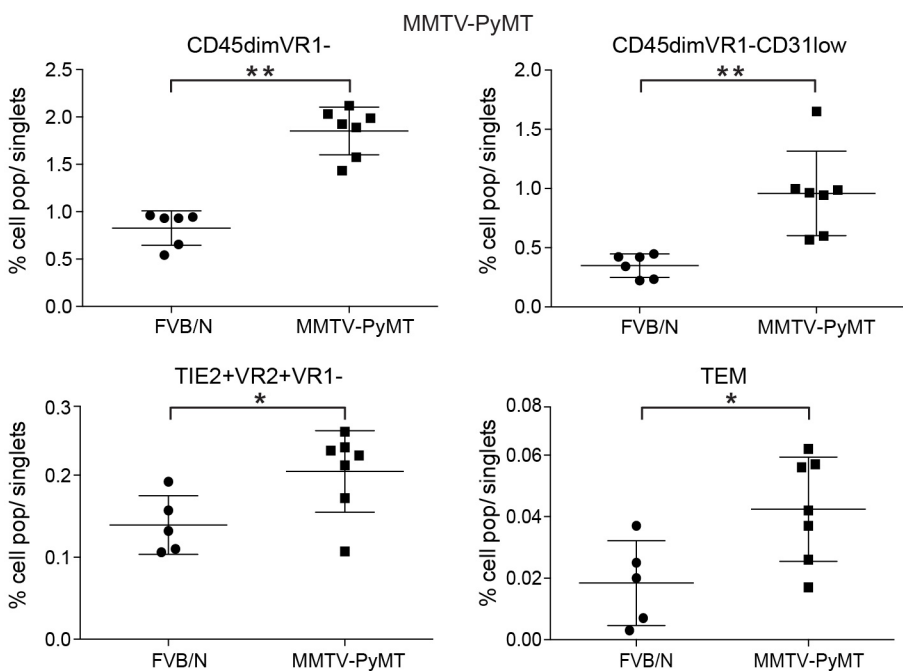


1. Hypothesis: tumor angiogenesis markers increase in tumor-bearing mice
2. Hypothesis: tumor angiogenesis markers are reduced upon anti-angiogenic treatment in tumor-bearing mice

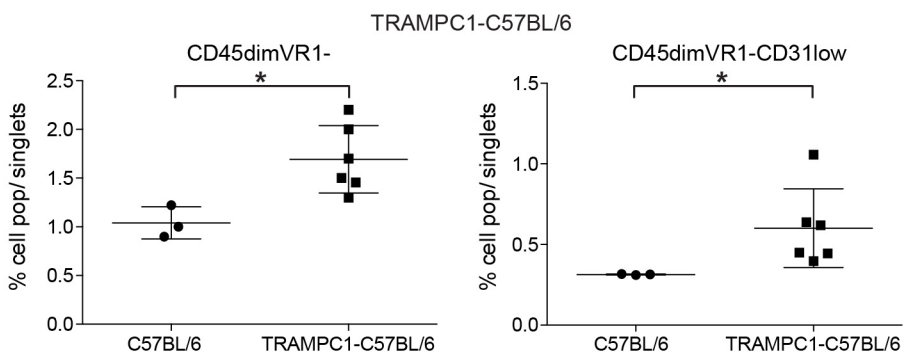
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CECs	EPCs
CD146+/TIE2+	CD45dim/CD146+
CD146+/VR2+	CD45dim/VR2+
CD146+/VR2+/TIE2+	CD45dim/TIE2+
CD146+/VR2+/VR1+	CD146+/VR1-
CD146+/VR2+/VR1+/TIE2+	CD45dim/VR1-
CD45-/CD146+	CD45dim/VR2+/TIE2+
CD45-/VR2+	CD45dim/TIE2+/CD146+
CD45-/TIE2+	CD45dim/TIE2+/CD146+/VR2+
CD146+/VR1+	CD45dim/CD146+/VR2+/VR1-
CD45-/VR1+/CD146+	CD45dim/CD146+/VR2+
CD45-/VR1+	CD45dim/VR1-/CD146+
CD45-/VR2+/CD146+	CD45dim/VR1-/VR2+
CD45-/VR2+/CD146+/VR1+	CD45dim/VR1-/TIE2+
CD45-/TIE2+/CD146+/VR2+	CD146+/VR2+/VR1-
CD45-/TIE2+/CD146+	CD45dim/CD13+/VR2+
CD45-/TIE2+/VR2+	CD45dim/CD13+
CD45-/VR1+/TIE2+	CD45dim/CD13+/VR1-
CD45-/VR1+/VR2+	CD13+/VR1-
CD45-/CD13+/VR2+	TIE2+/VR1-
CD45-/CD13+	VR2+/VR1-
CD45-/CD13+/VR1+	CD45dim/VR2+/TIE2+/VR1-/CD146+
CD45-/VR2+/TIE2+/VR1+/CD146+	CD45dim/VR2+/TIE2+/VR1-
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VR2+/VR1+/TIE2+	CD146+/VR2+/VR1-/TIE2+
CD13+/VR2+/TIE2+/VR1+	VR2+/TIE2+/VR1-
CD31low/VR2+	CD45dim/VR2+/TIE2+/VR1-/CD13+
CD45-/CD31low/VR2+	CD45dim/CD31low/VR2+/TIE2+
CD45-/CD31low/VR1+	CD45dim/CD31low/VR2+
CD45-/CD3low	CD45dim/VR1-/CD31low
CD45-/CD31low/VR2+/TIE2+	CD45dim/CD31low/TIE2+
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CD45-/CD31low/TIE2+	CD45dim/CD31low
CD45-/CD31low/TIE2+/cKIT+	CD45dim/CD31low/TIE2+/cKIT+
CD31low/TIE2+	CD45dim/cKIT+
CD31low/TIE2+/cKIT+	CD31low/VR2+/VR1-
CD31low/VR2+/VR1+	CD45-/CD13+/VR2+/cKIT+

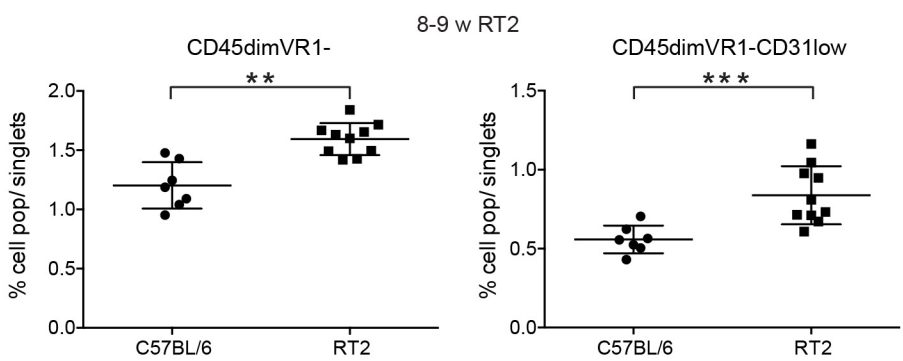
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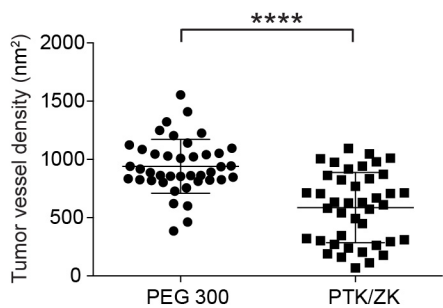
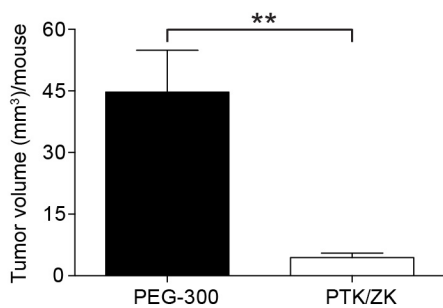
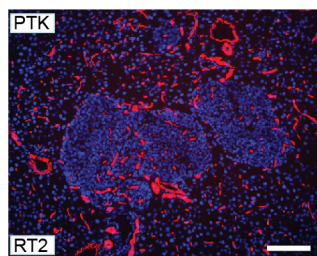
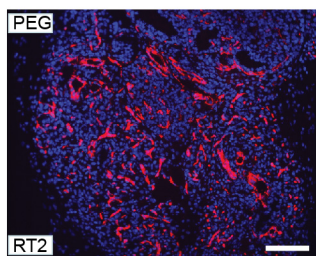
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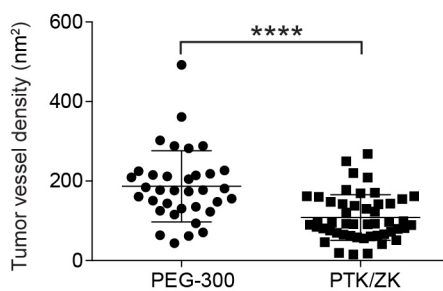
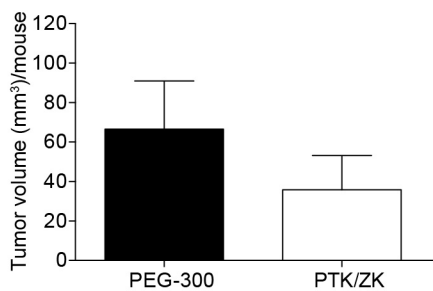
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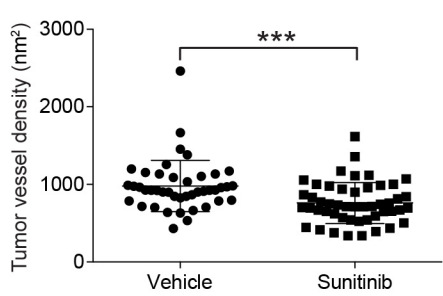
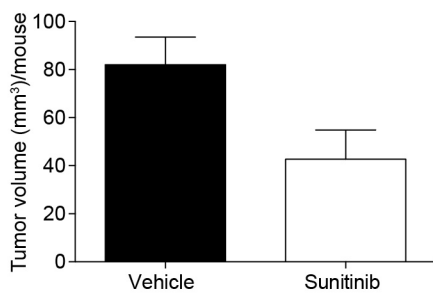
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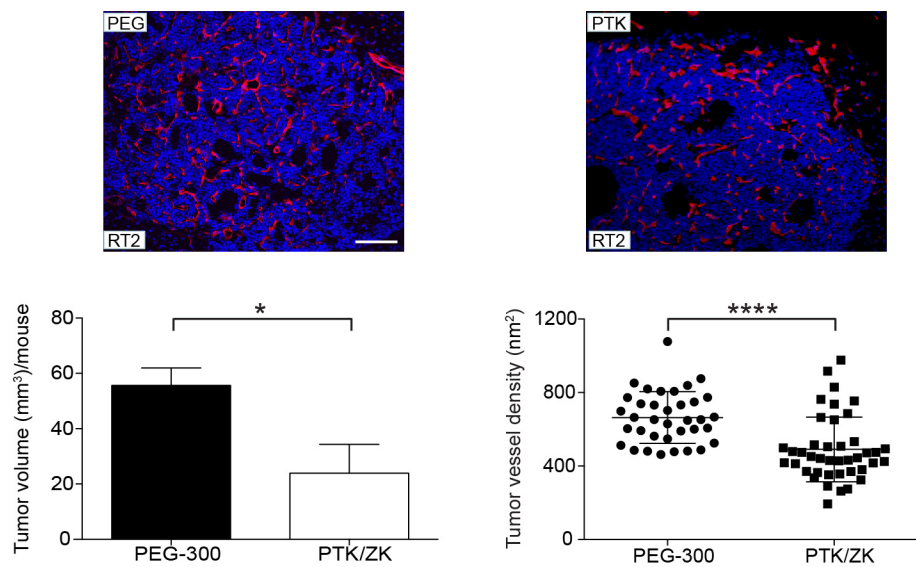
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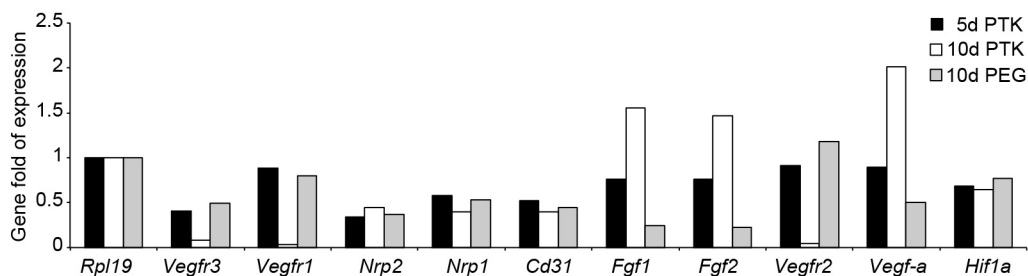
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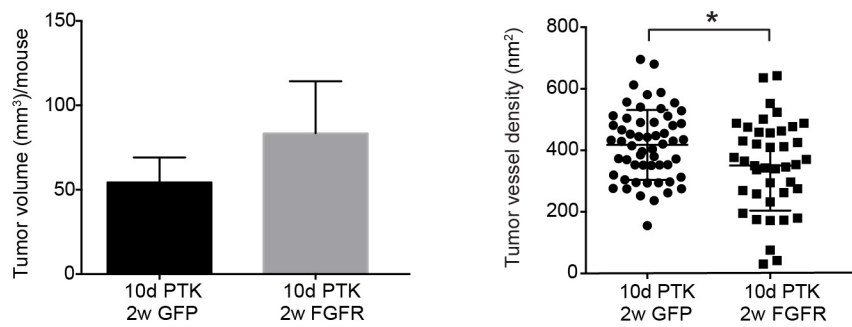
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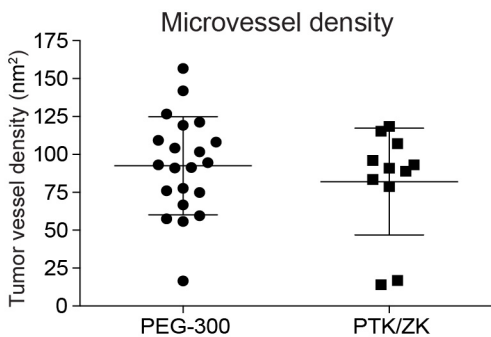
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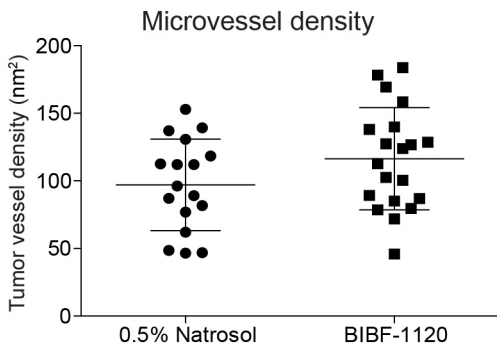
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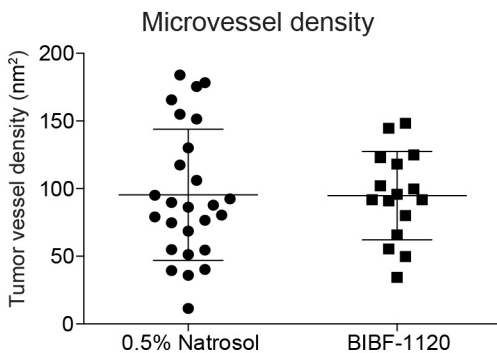
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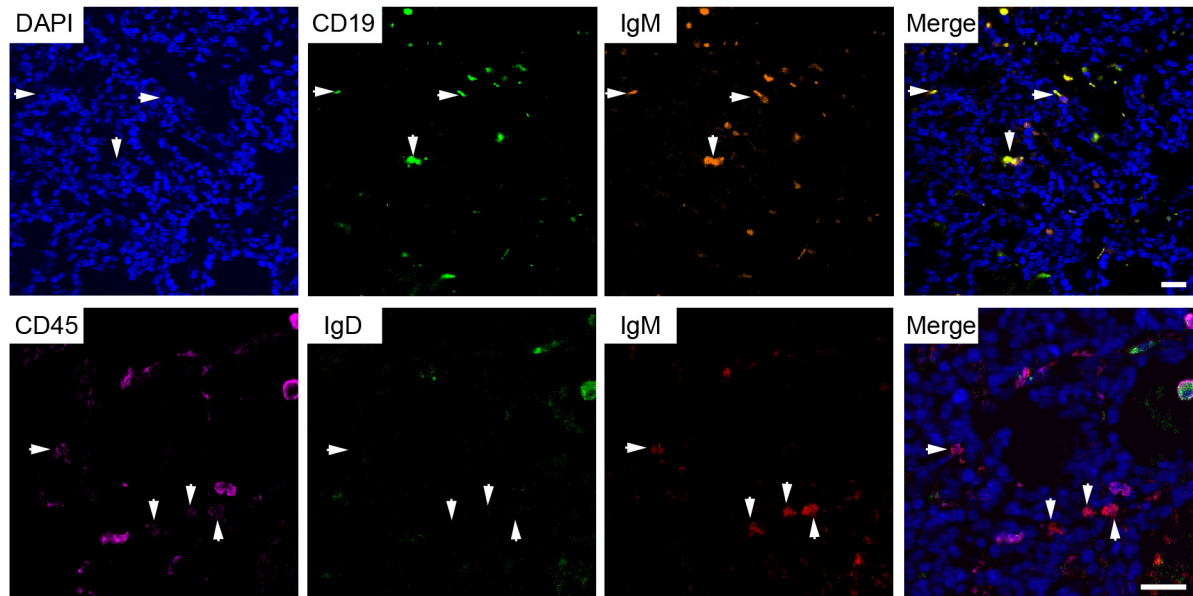
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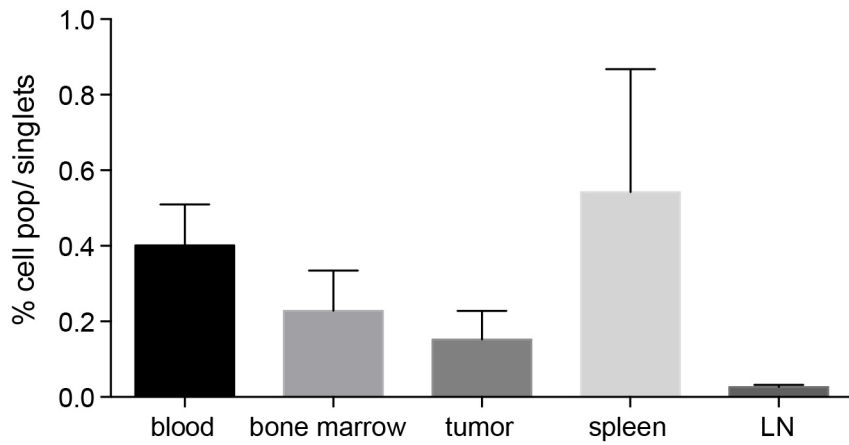
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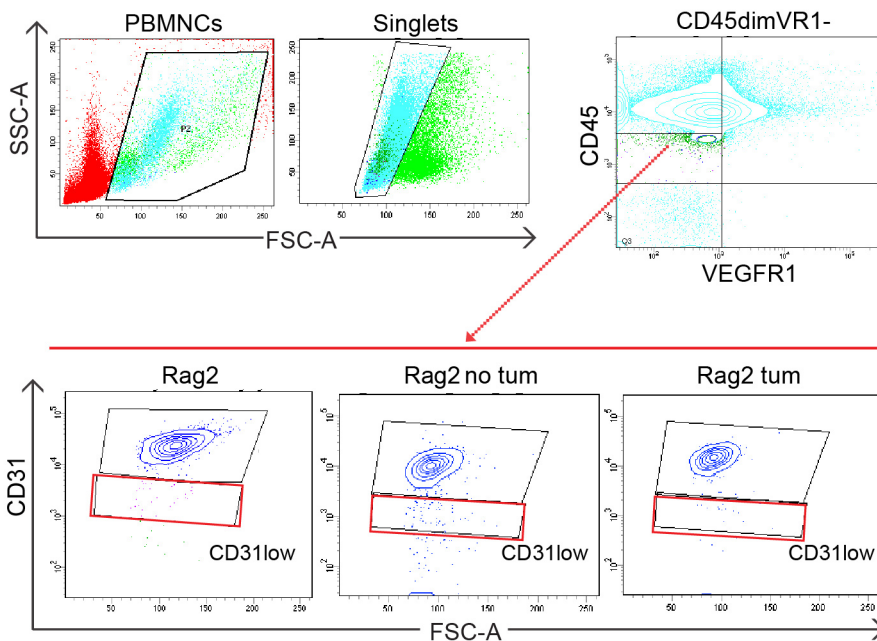
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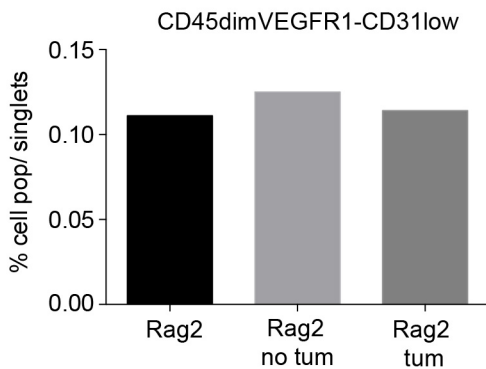
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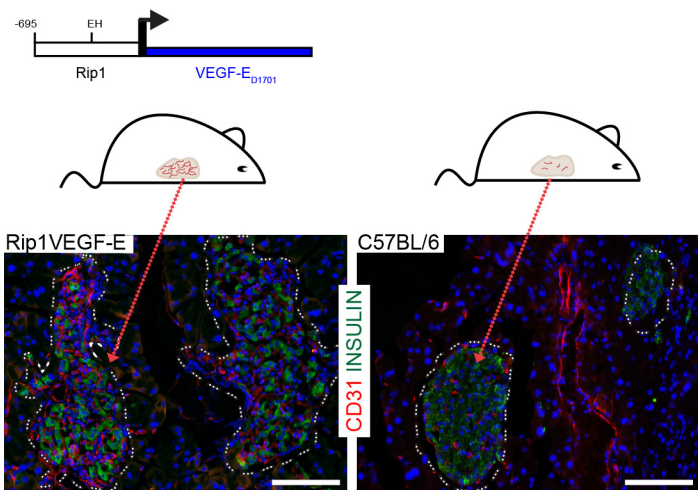
A



B



A



B

